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OF THE

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UNITED STATES ARMY,

TO THE

SECRETARY OF WAR

FOR

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IMPROVEMENTS.—St. Johns River, Fla., 1529; Upper St. Johns River, Fla., 1534; Volusia Bar, Fla., 1536; Ocklawaha River, Fla., 1537; St. Augustine Harbor, Fla., 1539; Indian River, Fla., 1541; northwest entrance, Key West Harbor, Fla., 1546; Caloosahatchee River, Fla., 1549; Charlotte Harbor and Pease Creek, Fla., 1551; Sarasota Bay, Fla., 1553; Manatee River, Fla., 1555; Withlacoochee River, Fla., 1556; Suwanee River, Fla., 1558; removing sunken vessels or craft obstructing or endangering navigation, 1560.
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APPENDIX O.

REPORT OF MAJ. F. A. MAHAN, CORPS OF ENGINEERS.

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PART III.

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REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

INSPECTION of the improvement of the South Pass of the Mississippi River, 1725.

APPENDIX R.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chefuncte River and Bogue Falia, La., 1742; Tickfaw River and its tributaries, La., 1744; Amite River and Bayou Manchac, La., 1747; Bayou Lafourche, La., 1750; Bayou Terrebonne, La., 1753; Bayou Plaquemine, Grand River, and Pigeon bayous, La., 1754; Bayou Courtableau, La., 1760; Bayou Teche, La., 1763; channel, bay, and passes of Bayou Vermilion, La., 1766; Mermentau River and tributaries, La., 1768; mouth and passes of Calcasieu River, La., 1770; harbor at Sabine Pass, Tex., 1774; Sabine River, Tex., 1778; Neches River, Tex., 1781; removing sunken vessels or craft obstructing or endangering navigation, 1782.

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REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS.

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REPORT OF LIEUT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

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CHARLES R. SUTER, lieutenant-colonel, Corps of Engineers, U. S. A., president; A. MACKENZIE, lieutenant-colonel, Corps of Engineers, U. S. A.; CHAS. J. ALLEN, major, Corps of Engineers, U. S. A.; GARLAND C. BROADHEAD and RICHARD S. BERLIN, *commissioners*.

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G. H. MENDELL, colonel, Corps of Engineers, U. S. A., president; W. H. H. BENYAURD, lieutenant-colonel, Corps of Engineers, U. S. A., and W. H. HEUER, major, Corps of Engineers, U. S. A., *commissioners*.

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APPENDIX Q.

INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 1, 1895.

GENERAL: I have the honor to submit my report for the fiscal year ending June 30, 1895, upon the improvement of the South Pass of the Mississippi River.

The report of Mr. C. Donovan, assistant engineer, with accompanying charts, is herewith, and gives all details relative to work done during the year, the present condition of the works, and of the channel.

At the Head of the Passes the upper dam was restored, and a dike built to close the waterway between it and the mainland below it.

Minor work was done by way of maintaining wing dams in the pass, and also the jetties and auxiliary works at the mouth of the pass.

During the year "a channel having a navigable depth of 26 feet was maintained through the shoal at the head of South Pass," and "through the pass itself," as required by law, and but seven days' dredging was done.

The law requires the maintenance of "a channel through the jetties 26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width."

From August 20 to August 31, 1894, both dates inclusive, said channel was not maintained at two localities, and since May 21, and up to June 21, the date of closing this report, the required channel was not maintained. The legal channel was restored June 21. Eighty-four days' dredging was done in this channel during the year.

The required channel was maintained beyond the sea ends of the jetties, and but five days' dredging was done. The area represented on chart No. 2 deepened during the year, a result due, in a large measure, to the effect of the storm of October 7 and 8, 1894.

Estimate of funds required for examinations and surveys at South Pass, Mississippi River, during the fiscal year ending June 30, 1897.

1 assistant engineer	$2,700
1 assistant engineer	1,500
1 steam engineer	1,200
1 water-level observer	120
6 seamen	3,370

Rent of office	$180
Rent of quarters for assistant engineer	240
Mileage and traveling expenses	150
Repairs to launch and boats	600
Supplies for launch and office	250
Contingencies	1,700
Total	12,010

Money statement.

July 1, 1894, balance unexpended	$1,152.97
Amount allotted for fiscal year 1894–95, under act of August 11, 1888	10,000.00
	11,152.97
June 30, 1895, amount expended during fiscal year	8,933.33
July 1, 1895, balance unexpended	2,219.64
July 1, 1895, outstanding liabilities	1,060.05
July 1, 1895, balance available	1,159.59
Amount allotted for fiscal year 1895–96, under act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1896	11,159.59

Statement of expenditures on account of appropriation for "examinations and surveys at South Pass, Mississippi River," for the fiscal year ending June 30, 1895, made in compliance with section 4 of river and harbor act of August 11, 1888.

Amount appropriated by act of August 11, 1888 ..... $10,000.00

EXPENDITURES.

1 assistant engineer, eleven months, at $200	$2,200.00
1 assistant engineer, five months, at $125	625.00
1 recorder, six months, at $100	600.00
1 engineer launch, eleven months, at $100	1,100.00
1 first-class seaman, eleven months, at $70	770.00
2 first-class seamen, twenty-two months, at $65	1,430.00
1 first-class seaman, eleven months, at $60	660.00
1 water-level observer, eleven months, at $10	110.00
1 first-class seaman, six days, at $2.25	13.50
Rent of office and quarters at Port Eads, La., eleven months, at $35	385.00
Stationery	23.60
Repairs to steam launch *General Reese*	296.60
Ship chandlery, hardware, etc	134.58
Hire of steam launch	30.00
Coal	498.50
Repairs to tide gauge	56.55
Total expenditures	8,933.33

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., June 29, 1895.

SIR: I have the honor to report upon the improvement of the South Pass of the Mississippi River, relative to the amount and character of the work done during the fiscal year ending June 30, 1895, the present condition of the jetties and works auxiliary thereto, and the condition of the channel which has been improved by them.

Messrs. James F. How and Estill McHenry, of St. Louis, Mo., as the legal representatives of James B Eads, deceased, continue to direct the work, under authority granted them in an act of Congress approved March 3, 1875.

The following charts accompany this report:

No. 1. Chart of the channel from South Pass Light-House, through the jetties, to deep water in the Gulf.

No. 2. Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.

No. 3. Chart of a part of South Pass, from South Pass Light-House to Grand Bayou.

No 4 Chart of a part of South Pass, from Grand Bayou to the Head of the Passes.

No. 5. Chart of the Head of the Passes.

No. 6. Plan and comparative profiles of South Pass.

No. 7. Diagrams showing changes in the Gulf for each year from 1876 to 1894.

AT THE HEAD OF THE PASSES.

Upper dam.—This structure, which is the most important one in the locality, was reenforced by a line of work immediately below it, consisting of three rows of piles each 7½ feet apart, the piles in each row being 8 feet apart, and are connected by waling pieces of 12 by 12 inch timber; willows weighted with earth in sacks were then placed between the piles. The original foundation of the older work is still in place above the new work, and will serve as a protection to it.

The new dam is 520 feet long, and in its construction the following materials were used: Two hundred piles, 1,015 linear feet of 12 by 12 inch timber, 201 screw bolts of seven-eighths inch iron 26 inches long, and 1,584 cords of willows.

Cut-off Dike.—By reference to chart No. 5, the waterway between upper dam and the mainland below it will be seen. There was a flow from South Pass into Pass a Loutre through this channel and a strong shore current in the opposite direction which was rapidly cutting the bank away. To arrest this action a dike of sheet piling 400 feet in length was built from the land toward upper dam. It terminated in 3 feet of water, and for the time being the work was deemed completed. A rapid scouring around the end soon began to take place, and it was decided to make the closure complete by continuing the work to a junction with upper dam.

Of this work 445 feet consists of two rows of piles 12 feet apart, the piles in each row being 7 feet apart, and between them willows weighted with earth in sacks were placed. Thence for a distance of 102 feet willows are confined between two rows of 4 by 4 inch stakes 12 feet apart; this connects the main work with the small area of land below upper dam; and to close a channel between this area and upper dam, and thus finally close the cut-off, three rows of stakes 7 feet apart were driven, and willows placed between them, making a dam 88 feet long.

Three wing dams were built along the dike, as shown on chart No. 5, in order to deflect from it the current caused by a strong eddy on either side. These dams are 42, 43, and 58 feet long, and 7½ feet wide; they are of the usual type, consisting of willows confined between two rows of piles, and weighted with earth in sacks.

The work is in good condition, and the following materials were used in its construction: Ten thousand five hundred and thirty-six linear feet of 8 by 12 inch timber for sheet piling, 29,448 linear feet of 1½ by 3 inch strips to form dovetail tongue and groove, 155 piles, 76 stakes, 70 linear feet of 8 by 12 inch timber, 815 linear feet of 8 by 8 inch timber, 158 screw bolts, 1,196 cords of willows, and 6,300 sacks.

West T-head.—Some new piles and willows weighted with earth in sacks were added to this work, and it is in fair condition.

The materials added to it were as follows: Forty-six piles, 60 linear feet of 12 by 12 inch timber, 240 linear feet of 8 by 12 inch timber, 41 screw bolts, 42 pounds of washers, and 805 cords of willows.

Mattress sills across Southwest Pass and Pass a Loutre.—The condition of these works remained unchanged during the year, and practically so since 1893.

The location of all works at the Head of the Passes is given on chart No. 5.

IN SOUTH PASS.

During the storm of October 7 and 8, 1894, one of the sheet-piling wing dams (No. 3) which was built in May, 1894, along the west shore of South Pass, just below the Head of the Passes Light-House (see Report of the Chief of Engineers for 1894, Appendix R, p. 1335), was subjected to such force of wind and sea that most of the piles were broken off along the line of the bottom of the river, some were pulled up, and on a few of the shore piles which remained in the ground the whole structure swung, as on a hinge, to the bank without being broken up.

This dam was rebuilt, and is now 68 feet long. Dams Nos. 2 and 4 in this locality were extended shoreward 24 and 23 feet, respectively, or rather the piles were driven on shore, so that the dams extend into the bank in order to prevent any flow around the shore ends.

The location of these dams is given on chart No. 5. They are in good condition, and the following materials were used in them during the year: Two thousand two hundred and eighty-six linear feet of 8 by 12 inch piling, 279 linear feet of 8 by 8 inch waling timber, 6,270 linear feet of 1½ by 3 inch strips to form dovetail tongue and groove, and 50 screw bolts.

In Goat Island Reach.—Wing dams Nos. 1, 2, and 5 in this reach received the addition of 1 pile, 2 screw bolts, and 78 cords of willows, and, together with other dams in this locality, are in good condition.

In Grand Bayou Reach.—Three new wing dams were built in this reach during the year. Their location is given on chart No. 4. They are Nos. 15, 16, and 17, and are, respectively, 71, 40, and 32 feet long, consisting of two rows of piles 15 feet apart, the piles in each row being 8 feet apart, and are connected by waling timber. Willows weighted with earth are placed between these piles.

Dams Nos. 4, 6, 8, and 13 were repaired, and, together with those mentioned, and also No. 3, are in good condition. The other and older ones in this locality are no longer important and are not maintained.

The following materials were used in the construction and maintenance of wing dams in this reach during the year: Sixty-seven piles, 581 linear feet of 8 by 10 inch timber 100 screw bolts, and 775 cords of willows.

AT THE MOUTH OF SOUTH PASS.

All the works at this locality are represented on chart No. 1.

East Jetty.—No work was done on this jetty during the year. Its condition is as follows: For 3,500 feet from its initial point it is buried by the land formation which has taken place since it was built.

The recession of the shore on the eastward of this jetty has been very slight during the past two years, although for some years previous it had been receding rapidly. Possibly this recession has been permanently arrested; and if so, this portion of the east jetty will be permanent.

For the next 2,700 feet this jetty is as originally built; the riprap which covers the top mattress is about 2 feet below average flood tide. From 1889 to 1893 a capping was placed over 2,200 feet of this portion of the jetty, consisting of cribs of yellow pine timber filled with stone. These deteriorated rapidly, and while a few of them are yet in place they are valueless as a part of the work.

The remainder of this jetty is capped by a concrete wall built upon the original foundation mattress, and with the exception of 304 feet, in two sections, of older construction, and another of the newer, where the foundation was undermined, causing the wall to settle, although it was not otherwise displaced, the work is in fair condition and effectually resisted the storm of October 7 and 8, 1894, which was one of the most violent that has ever visited this locality.

The height of the concrete wall averages 2 feet above average flood tide. The average settlement during the year was 0.16 of a foot, and since its completion in September, 1889, the average settlement has been 0.79 of a foot.

West Jetty.—Two hundred and seventy feet of the outer end of this jetty is 4½ feet below the surface of the water, and there is a depth of 2 feet of sand over the concrete work. The remainder of the jetty is permanently secured by the accumulation of silt about and over it, in which the sea grass is growing, so that it is lost to view.

Inner East Jetty.—A crib 112 feet long, 9 feet wide, and 3½ feet high was placed on this jetty near the sea end, being a continuation upstream of the work of capping it. Courses of timber were added to other cribs at the outer end of the jetty, and willows and stone were added to the work at other localities.

About one-half of this jetty is in good condition, and the remainder is about 2 feet above average flood tide, but is being built up as rapidly as the force employed and the supply of materials will admit.

The following materials were used in the maintenance of this work during the year: Thirty-four piles, 5,851 cords of willows, 548 cubic yards of stone, 1,425 linear feet of 12 by 12 inch timber, 1,524 linear feet of 3 by 12 inch plank, 264 driftbolts, and 12 screw bolts.

Inner West Jetty.—During the month of July a crib 242 feet long, 9 feet wide, 3½ feet high on one side and 4½ on the other was placed at the sea end of this jetty and upon the other cribs previously placed, but which had settled to 4 feet below the surface of the water.

An additional course of timber was placed on the crib near West Light for a distance of 202 feet below that light.

The storm of October 7 and 8, 1894, demolished about 100 feet of the sea end of this jetty, together with the dam connecting it with the main jetty, and also Dam 27. Some of the work is still in place, however, and may serve as a foundation for other work.

This jetty is in rather an indefinite condition at present, but as a quite solid bank has formed back of it, and as most of it is not subject to violent wave action, its condition is not of great importance so long as water does not escape from the channel.

The following materials were used in maintaining this jetty during the year: Thirty-one piles, 382 cords of willows, 140 cubic yards of stone, 3,128 linear feet of 12 by 12 inch timber, 2,994 linear feet of 3 by 12 inch plank, and 369 driftbolts.

WING DAMS.

Three new wing dams were built during the year; they are Nos. 10, 47, and 48, and 48, respectively, 27 by 12 feet, 29 by 14 feet, and 43 by 10 feet. Twenty-four of these structures, out of a total of 32, were repaired, so that they are at present in good condition.

The dam which connects the end of the east jetty with that of the inner east jetty was built up for a distance of 122 feet from the latter by the addition of further crib work, and this portion is now in good condition. For the remainder of the distance to the main jetty the foundation crib is in place, but below the surface of the water.

The materials used in wing dams during the year were as follows: One hundred and fifty-nine piles, 1,657 cords of willows, 348 cubic yards of stone, 684 linear feet of 12 by 12 inch timber, 389 linear feet of 8 by 12 inch, 148 feet of 4 by 10 inch, and 1,164 feet of 3 by 12 inch lumber, 295 screw bolts, and 224 driftbolts.

DREDGING.

From June 18, 1894, to June 21, 1895, both dates inclusive, the dredge boat worked 96 days of 10 hours each, as follows: Seven days in Grand Bayou Reach, 5 days in the channel beyond the sea ends of the jetties, and 84 days in the jetty channel.

THE PLANT.

A blacksmith shop and storehouse for machinery, etc., were built; the smokestacks of the dredge boat were renewed, two steel barges, a stone flat, two pile drivers, one derrick boat, and a launch repaired.

EXAMINATIONS AND SURVEYS.

The result of examinations and surveys made during the year were reported monthly, and the same are embodied in this report, and comparisons made with similar results obtained during previous years. The different charts and tabulated statements contain all this information in detail.

The results of tidal, sediment, and velocity determinations for a period of years were given in my last report, and as those obtained during the year add nothing of interest or importance they are omitted in this report.

On March 2, 1894, a self-registering tidal apparatus was put in operation in Garden Island Bay and referred by level to Port Eads gauge, but as yet the results do not extend over a sufficient period of time for an equitable comparison with those of the Port Eads gauge.

Everything is in readiness for another gauge, which is expected here soon and which will be established in East Bay, to the westward of South Pass. The records of these two gauges will give an interesting and valuable determination of Gulf level referred to Port Eads gauge, which is connected with a line of precise levels which were run under the direction of the Mississippi River Commission.

In connection with results which will be given later on, particularly with reference to the jetty channel, I would call attention to the exceptional stage of river which obtained during the year. We have the records since 1875, during which time there has not been as long a low-river period as during the past year; in fact, we had practically no high river.

On July 6, 1894, Carrollton gauge read 2.5 feet and on December 14 it read zero. It began to rise January 19, 1895, and on February 4 the stage was 7.7 feet; it began to fall at once, and on February 26 recorded five-tenths of a foot above zero. On March 10 it began to rise again, reaching 10.1 feet on April 7, since which time it has been falling, and on June 15 it read 2.2 feet.

From July 4, 1894, to June 16, 1895, a period of 347 days, there were but 84 days when Carrollton gauge read 3 feet or more, 66 days 5 feet, 31 days 7 feet, and 10 days 9 feet.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5. In comparison with a similar survey made one year previous I find, by using section G H, that for 1,400 feet from the east shore there is an average shoaling of 1½ feet, thence for 2,400 feet a shoaling of 5 feet, thence for 800 feet a deepening of 3 feet, thence to the west shore a slight change in favor of deepening.

On section I J there is a shoaling throughout, being greatest from 1,200 to 2,700 from the east shore, and averages 6 feet.

On lines C D and E F the shoaling varies from 2 to 5 feet.

On line A B from 2,600 to 1,100 feet above upper dam there is a shoaling of 3 feet, thence for 500 feet a slight deepening, thence for 2,500 feet an average deepening of 7 feet, thence for 1,000 feet a shoaling of 11 feet, thence to the end of the line a deepening varying from 3 to 11 feet.

In Pass a Loutre, at the lower limit of the survey, the 26-foot curve moved to the westward 1,300 feet, and at the upper limit 700 feet. The 30-foot curve moved to the westward 400 feet, but the west shore, which had been cutting away rapidly during several years previous, receded but slightly during the year.

As a general result the area at the Head of the Passes shoaled during the year, but has deepened since 1875.

The profiles on chart No. 6 show the deepening in the entrance to South Pass during the year, and since 1875.

At present the channel into South Pass is practically as shown on chart No. 5. The required "navigable depth of 26 feet" was maintained during the year.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

The charts of this survey, which were made during the month of September, 1894, are Nos. 3 and 4, and the following table compiled therefrom gives the depth and width of channel in the different reaches.

Tabulated statement of the depth and width of channel throughout South Pass of the Mississippi River, from East Point to 30-foot depth in the main river, given in separate reaches one-fourth of a mile in length, from a survey made in September, 1894.

Locality.		Available depth.	Available width of—	
From—	To above East Point.		26-foot channel.	30-foot channel.
East Point	¼ mile	29	245	(a)
Above East Point:				
¼ mile	½ mile	29	280	(b)
½ mile	¾ mile	29	280	(c)
¾ mile	1 mile	33	240	100
First mile		29	240	.....
1 mile	1¼ miles	29	230	(d)
1¼ miles	1½ miles	28	160	(e)
1½ miles	1¾ miles	26	160	(f)
1¾ miles	2 miles	27	100	(g)
Second mile		26	100	.....
2 miles	2¼ miles	27	300	(h)
2¼ miles	2½ miles	30	430	130
2½ miles	2¾ miles	32	420	310
2¾ miles	3 miles	33	410	340
Third mile		27	300	.....
3 miles	3¼ miles	32	330	220
3¼ miles	3½ miles	31	340	170
3½ miles	3¾ miles	30	340	90
3¾ miles	4 miles	32	350	190
Fourth mile		30	330	90
4 miles	4¼ miles	33	350	200
4¼ miles	4½ miles	29.6	410	(i)
4½ miles	4¾ miles	32	310	210
4¾ miles	5 miles	35	250	160
Fifth mile		29.6	250	.....
5 miles	5¼ miles	28	240	(k)
5¼ miles	5½ miles	27	200	(m)
5½ miles	5¾ miles	26.4	160	(n)
5¾ miles	6 miles	28	300	(o)
Sixth mile		26.4	160	.....
Above East Point:				
6 miles	6¼ miles	27	210	(p)
6¼ miles	6½ miles	27	130	(q)
6½ miles	6¾ miles	30	340	30
6¾ miles	7 miles	29	360	(r)
Seventh mile		27	130	.....
7 miles	7¼ miles	29	360	(s)
7¼ miles	7½ miles	28	380	(t)
7½ miles	7¾ miles	34	320	260
7¾ miles	8 miles	33	320	200
Eighth mile		28	320	.....
8 miles	8¼ miles	31	330	140
8¼ miles	8½ miles	30	300	180
8½ miles	8¾ miles	33	240	170
8¾ miles	9 miles	33	210	130
Ninth mile		30	210	130
9 miles	9¼ miles	33	250	100
9¼ miles	9½ miles	28	280	(u)
9½ miles	9¾ miles	29	340	(v)
9¾ miles	10 miles	46	300	250
Tenth mile		28	250	.....
10 miles	10¼ miles	36	300	250
10¼ miles	10½ miles	40	280	220
10½ miles	10¾ miles	33	290	240
10¾ miles	11 miles	32	320	200
Eleventh mile		32	280	200
11 miles	11¼ miles	45	400	350
11¼ miles	11½ miles	29	(*)	(w)
11½ miles	11¾ miles	29	(*)	(x)
11¾ miles	12 miles	†32	(†)	(†)
Twelfth mile		29	400	.....

* Very wide. † In Mississippi River, above Head of the Passes.

Length of the portion of this reach not having a central depth of 30 feet.

	Feet.		Feet.
(*a*)	850	(*o*)	1,320
(*b*)	1,110	(*p*)	1,320
(*c*)	150	(*q*)	970
(*d*)	150	(*r*)	210
(*e*)	1,320	(*s*)	800
(*f*)	1,320	(*t*)	180
(*g*)	1,320	(*u*)	1,320
(*h*)	900	(*v*)	150
(*i*)	60	(*w*)	180
(*k*)	250	(*x*)	260
(*m*)	1,320		
(*n*)	1,320	Total	16,780

From an inspection of the comparative profiles on chart No. 6, it will be seen that some sections deepened while others shoaled, the general change being in favor of shoaling. The greater shoaling took place in a reach 2 miles in length, commencing three-fifths of a mile above South Pass Light-House, and averages about 4 feet.

As will be seen from the profiles referred to, there has been a decided shoaling throughout the pass since 1875, although the greatest shoaling has taken place in the deepest places in the pass, while the shoaler places have changed the least, in consequence of works built to prevent shoaling.

The required channel having "a navigable depth of 26 feet" was maintained during the year.

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties and beyond them to deeper water in the Gulf is shown on chart No. 1, and from profiles on chart No. 6, it will be seen that it shoaled quite uniformly during the year, and amount averaging about 3 feet in vertical height.

From August 20 to August 31, 1894, both dates inclusive, the required channel, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," was not maintained at two localities, from 10,220 to 10,560 feet below East Point, and from 9,000 to 10,000 feet below said point.

From and including May 21, 1895, and up to the present time, June 21, the legal channel was not maintained for a distance of 3,100 feet, which comprises portions of the reach from 6,540 to 10,540 feet below East Point. The cause of this shoaling was no doubt due to a sudden fall in the river after it had reached a stage when the power of the current was reduced, and yet while the water was heavily charged with sediment. On June 21 the legal channel was found to have been restored.

Owing to exceptionably unfavorable weather it has been impossible to use the dredge boat except for seventeen days since May 21, otherwise the channel might have been restored to the required width sooner.

Tabulated statement relative to the available depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made during the fiscal year ending June 30, 1895.

Date.	Distances from East Point, in feet.								
	0 to 2,000.			2,000 to 4,000.			4,000 to 6,000.		
	Available depth.	Available width of—		Available depth.	Available width of—		Available depth.	Available width of—	
		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.
1894.									
June	33.2	250	145	31.2	350	260	32.9	310	150
July	32.1	320	125	31.6	340	250	31.7	290	155
August	31.2	260	90	30.5	330	240	31.2	280	80
September	31.3	240	100	30.6	330	130	30.6	260	60
October	30.4	240	40	30.4	310	50	30.1	260	10
November	30.3	240	50	30.3	300	30	30.6	280	40
December	30.8	280	60	30.6	320	40	31.3	300	90
1895.									
January	30.6	245	70	31	340	80	31	265	70
February	30.8	245	75	31.3	310	75	30.6	305	80
March	31.7	270	70	31	320	80	30.5	270	40
April	30.9	260	80	30.8	330	60	30.4	270	70
May	30.3	250	55	30.4	290	65	30.3	210	25
June	30.3	250	35	30.6	290	40	30.5	220	25

Tabulated statement relative to the available depths and widths of channel, etc.—Continued.

Date.	Distances from East Point, in feet.								
	6,000 to 8,000.			8,000 to 10,000.			10,000 to 12,000.		
	Available depth.	Available width of—		Available depth.	Available width of—		Available depth.	Available width of—	
		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.
1894.									
June	33	260	155	32.7	225	115	33.6	220	120
July	31.5	260	160	31.8	220	110	32.6	220	100
August	30.2	240	65	*28.9	160	(*)	30.3	200	30
September	30.5	240	40	30.3	220	40	30.5	210	50
October	30.8	230	60	30.6	215	60	30.4	230	60
November	30.3	240	30	30.3	220	20	30.8	225	40
December	30.7	250	80	30.7	235	40	30.7	240	50
1895.									
January	30.5	230	80	30.4	230	60	30.8	240	70
February	30.7	230	70	30.7	215	40	30.7	200	70
March	30.5	220	40	30.6	205	30	31.1	220	40
April	30.5	230	25	30.7	225	65	31.1	230	70
May	30.3	†130	15	30.8	†115	15	30.5	‡180	15
June	30.2	210	10	30.2	205	20	30.4	225	10

* August 20 to 31, 1894, both dates inclusive.
† May 21 to June 18, 1895, both dates inclusive.
‡ May 21 to June 20, 1895, both dates inclusive.

Beyond the ends of the jetties and on a direct course from there to sea the required channel was maintained during the year, and but five days' dredging was done.

The following table gives the available depths through the jetties at various dates since 1875 and explains the changes in the depth of that channel from that time to the present:

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875—June	22.5	18.7	16.7	10.2	9.7	9.2
1876—May	23.3	20.3	22	21	17.1	15
August	23.5	19.6	21	23.5	23	19.6
November	22	20.3	21.1	21.2	21.1	20.3
1877—March	24.1	21.1	23.2	22	21.2	20.5
July	24.9	24	26	23.8	23.5	20.3
October 25 to December 14	26.3	24.4	28.5	24.2	23	23.7
1878—March	26	25.9	35.5	25.4	24.3	23
December	28.4	26.4	35.7	27.1	25.3	23
1879—March	28.6	27.5	43.4	27	27	27
June	27.5	28.4	47.7	29.2	29.2	28
July 8	30.5	30.7	.....	31	30.7	30.5
December	31	31	48.3	31.7	31.8	30.8
1880—June	31	32.5	47.8	31.4	35.1	32
July	30.5	31	44	30.8	31.5	30.5
August	30.5	30.4	46	32	32	30.5
September	30.7	31	44.4	30.6	32	31
October	31	31.5	41	30.3	31	30.5
November	30.6	31	40.3	30.8	30.9	30.5
December	30.9	30.6	43	30.8	31	30.3
1881—January	30.5	30.4	41.9	33.8	30.7	30.3
February	30.4	30.2	41.6	32	31	30
March	31.5	31.2	41.3	32	32	30.5
April	30.4	30	43	33	33	30.5
May	30.2	30.5	42.7	32.6	30.5	31.2
June	30	30.5	43.8	32	31.7	31.7
July	31	32	42.5	33.5	33	32
August	30.1	32	37.6	32	31	30.2
October	30.2	30.3	38.3	31.4	31.2	30.3
1882—January	30.5	30.4	41.3	31.1	30.2	30.7
February	31.8	36	39.7	30.5	30.8	30.2
March	31.2	30.6	39.2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33
May	30.5	32.5	39.4	31	31.3	31
June	30.8	35.5	39	31.3	31.8	31
July	30	32.7	38.7	30.6	31.3	31.5
August	30.3	32.2	38.1	31.8	31.8	30.5

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1882—September	30.1	31.5	38.3	31.9	30.8	30.5
October	30	31	37.1	31	31.4	31.2
November	30	32	38.1	21.5	31.2	31.2
December	31	31	37	31.2	31	30.4
1883—January	31	31	35.2	30.2	30.1	30.1
February	31.2	31.2	36	30.5	30	30.1
March	32.3	32.6	45.7	31.5	30.3	30.3
April	33.7	35	44	32.2	30	39
May	33.2	36.3	46	32.3	30.3	32.4
June	32.5	34.2	45	33.4	31	33
July	33.8	34.9	44	32	31.5	31.8
August	32.1	33.2	48	33.4	33.4	32.2
September	33.4	34.3	46	32.3	32.3	30.6
October	32.7	34.1	41.5	32	32	30.5
November	31	33.8	43.6	34.5	31.5	31
December	30.5	32.6	43	31.6	31.6	30.2
1884—January	31.2	32.2	39.2	32.7	31.8	30.3
February	32	31.5	41.3	31.6	31	30.7
March	35.7	39.5	41.6	34	33.8	38.7
April	35.3	37.3	41.5	31.7	32.7	35.4
May	34.9	35.8	42.3	34.3	35.1	33
June	35	35.8	41.1	34	35	35
August	31.9	35.8	41.9	33.9	35	32 *
September	32	34	39	33.1	33.7	33.5
October	31.1	33.4	38.6	32.6	32.6	32.5
November	32.8	32.8	37.2	32.2	32.4	30.8
December	31.6	32.6	37.1	31.1	31.5	31.4
1885—January	36.7	36.4	36.9	33.1	34.6	32.8
February	41.7	36.3	35.7	30.5	34.1	36.2
March	35.5	36	36.1	31	31.7	35.7
April	36	35.5	37	32	32.6	32
May	36.7	35	35.6	31.5	33.5	31.5
June	34.7	33.7	35.7	32.8	32.8	31.3
July	36.3	33.1	36.5	33.7	33.6	31
August	36.5	35.6	37.6	33	32	31
September	35.3	33.3	35.2	32.2	30.7	31.7
October	33.8	33.7	35.8	31.3	30.4	30.4
November	32.7	32.8	35.1	30.8	30.6	30.1
December	33	32.2	34.2	30.9	30.5	30.6
1886—January	33.6	32.5	33	30.2	30.2	28.5
February	32.8	32.8	34.1	31.3	30.9	30
March	32.8	35.8	34	35	33.1	32
April	35.4	34.5	34.5	33.7	33.7	31
May	35.9	35.6	34.2	31	36	34.4
June	38.2	35.2	33.4	33.2	34.5	36.5
July	36.7	36.7	36.2	32.8	32.7	37
August	35	36	35.7	34.8	33.8	34.7
September	34.5	35.6	34.6	33.7	33.6	33
October	35	36.2	34.4	33	34.1	33
November	34.5	35.6	34.8	32.9	33	33.5
December	34	35	35.3	33.6	32.6	33
1887—January	33.6	34	33.3	32.3	32.7	33.4
February	36.4	34.4	35.4	31.3	34.1	32.4
March	35.5	35.5	32.6	35.5	35.5	33.8
April	38.8	37	33.7	31	34.8	35.5
May	39.4	35.3	37.1	31.2	34.2	38.1
June	39	35.4	37.5	32.3	34.1	35.2
July	39	36.4	35.8	34	32	34
August	35.7	34.6	34.7	33.6	31.6	32.7
September	36	34	35	35	32.7	32.2
October	36.2	34.2	34.3	32.1	32.2	31.8
November	35.9	32.9	33.8	30.7	31.8	31.2
December	34.7	32.7	33.9	30.9	31.7	31.8
1888—January	35.6	32.5	33.7	30.5	31.5	32.2
February	34.3	32.4	32.5	31	31	32
March	34	33	32.6	30.5	31.3	30.9
April	36.3	34.8	33.8	31	35	31.4
May	35.2	35.2	34.3	31.6	33.6	33
June	32	33	33	31.4	35.5	33.2
July	34.2	34	33.8	31	31.9	33.6
August	33.7	33.7	33.7	31.2	31.2	33.2
September	32.7	32.7	32.8	30.8	31	32
October	33.3	33.3	32.3	30.6	30.4	30.4
November	31.8	32.8	31.7	30.6	30.6	30.8
December	31.4	32.4	31.6	30.3	* 29.2	30.7
1889—January	31	31.3	30.6	30.3	31	30.9
February	32.4	32.5	31.8	32.8	31	32.5
March	30.2	32.2	30.4	32.3	31.8	31.6
April	30.8	32.1	31.2	32.8	32.8	30.6
May	30.8	32	30.7	32.6	31.2	30.8

* From December 28, 1888, to January 4, 1889, inclusive.

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 6,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1889—June	30.4	32.2	31.3	31.5	31	30.8
July	30.3	31	31	32.4	31.3	31
August	31.7	31.4	31.5	31.6	31.4	31
September	30.9	31.3	31.2	31	31.1	.....
October	31.6	31	31.2	31	31.7	*29.6
November	31	31.2	31.2	31	31.3	31.4
December	30.8	31	31.2	31	31.7	31.2
1890—January	30.8	30.8	31.2	30.6	31	31
February	31.7	30.7	31.5	32.6	34.4	33
March	36.4	33.2	34	34	34	33.6
April	33.4	36	35	35	38.7	34.5
May	32	34	34	36	39	34
June	32	33.5	33	34	39.8	35
July	32.4	33.4	34	34	39	37
August	32	33	33	32.7	35	34
September	30.5	31.4	33	33	35	33
October	32	31	31	30.5	34	32.8
November	30.6	31.2	30.6	30.6	34	33
December	31.5	31.2	30.7	30.7	32.3	33.5
1891—January	31	31	31.2	32.2	32.3	32.5
February	31.7	31	31.4	32.5	35.2	32.7
March	32	34.3	36.4	37.5	36	34.6
April	30.5	32	36.5	39	36.4	34.2
May	30.3	32	32	35	36	34
June	33	31.1	32	34.7	37	35
July	31.4	30.4	30.4	33.3	35.8	34.8
August	31	31	31	32.3	32.9	31.4
September	30.6	30.6	30.7	31	31.5	.....
October	31	30.8	30.8	31.2	31.2	30.7
November	31.2	31	31.3	31.2	31.1	30.6
December	30.1	30.3	30.6	31.4	31.3	32
1892—January	31.3	31.6	31.3	31.3	31.8	32.2
February	30.5	30.8	30.8	31	31.1	31.7
March	30.8	30.7	31.4	31.7	31.2	31
April	32	32	33.7	32	30.5	30.6
May	†28.1	‡29.6	38	35	33	32
June	§30.4	32.3	36	37	*36.6	33.2
July	31.5	33	32	35.6	38	34.2
August	31.5	33.5	33.8	34.6	34.8	35
September	31.2	32.7	31.2	33.6	33.7	33.5
October	31.8	32.5	31.8	31.5	32.7	32.3
November	31.5	32.1	31.5	32	33	32.6
December	31	31.5	31.6	32.1	33.5	33.1
1893—January	31.6	32.2	31.3	32.1	32.2	34.1
February	31.6	31.6	31	31.6	32.7	34
March	33.6	34.6	33.1	30.8	31.2	32.4
April	33.6	35	33.6	31.6	32.3	32.6
May	32	34	33	33	32.5	32
June	32.7	33	33.8	36	31.7	30.5
July	32	33.3	34	35	36.7	35
August	32	32	34	34.5	35.3	34.2
September	31.5	31.5	32.4	33.5	35.3	31.8
October	31.5	32.2	32.7	33.2	34.2	33.2
November	31.4	32.7	33.3	32.8	34.3	33
December	31	32	33	33	34.8	33.5
1894—January	32.1	32.1	33.5	33.2	36	34.5
February	30.6	32.2	32.6	32.6	34.5	33
March	32.8	31.8	31.7	32	34.2	34
April	34.3	31.4	32.7	33	32.3	34
May	32	32	34	34	34	33
June	32.2	31.2	32.9	33	32.7	33.6
July	32.1	31.6	31.7	31.5	31.8	32.6
August	31.2	30.5	31.2	30.2	‖28.9	30.3
September	31.3	30.6	30.6	30.5	30.3	30.5
October	30.4	30.4	30.1	30.8	30.6	30.4
November	30.3	30.3	30.6	30.3	30.3	30.8
December	30.8	30.6	31.3	30.7	30.7	30.7
1895—January	30.6	31	31	30.5	30.4	30.8
February	30.8	31.3	30.6	30.7	30.7	30.7
March	31.7	31	30.5	30.5	30.6	31.1
April	30.9	30.8	30.4	30.5	30.7	31.1
May	30.3	30.4	30.3	30.3	30.8	30.5
June	30.3	30.6	30.5	30.2	30.2	30.4

* From October 1 to October 5, inclusive.
† Depth less than 30 feet from April 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.
‡ From December 28, 1888, to January 4, 1889, inclusive.
§ Depth less than 30 feet from May 20 to June 20, both dates inclusive, and varied from 28.1 to 29.6 feet.
‖ August 20 to 31, both dates inclusive.

SURVEY BEYOND THE ENDS OF THE JETTIES.

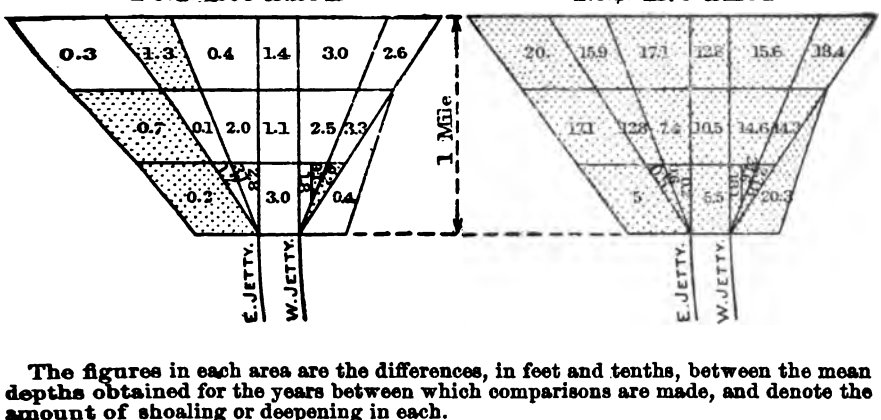
The chart of this survey is No. 2. By reference to the following diagrams, and those on chart No. 7, it will be seen that all the curves receded during the year, the 40-foot curve showing the greatest recession—of 207 feet—and the 100-foot curve the least, being 44 feet. (For diagrams, see page 1736.)

From 1877 to 1894, as the diagram explains, all the curves advanced.

It is evident from this that the area under consideration deepened during the year, and shoaled since 1877.

The distribution of this shoaling or deepening over an area containing 1¼ square miles is obtained by dividing it into twenty-one lesser areas, then determining the mean depth of each, and finally of the whole, and comparing them with results similarly obtained from previous surveys.

The following diagrams contain the results of these determinations:



The figures in each area are the differences, in feet and tenths, between the mean depths obtained for the years between which comparisons are made, and denote the amount of shoaling or deepening in each.

No. 1 compares the mean depths in 1893 with those in 1894, and No. 2 compares those in 1876 with those in 1894. Shaded areas have shoaled.

From the diagrams it will be seen that, as a general rule, the areas nearest the ends of the jetties show the greatest deepening. Much of this is due to the effect of the storm of October 7 and 8, 1894; the wind, being northeasterly, sent a very strong current across the ends of the jetties, with beneficial effect; and some of it is due to the action of the salt-water currents during low river.

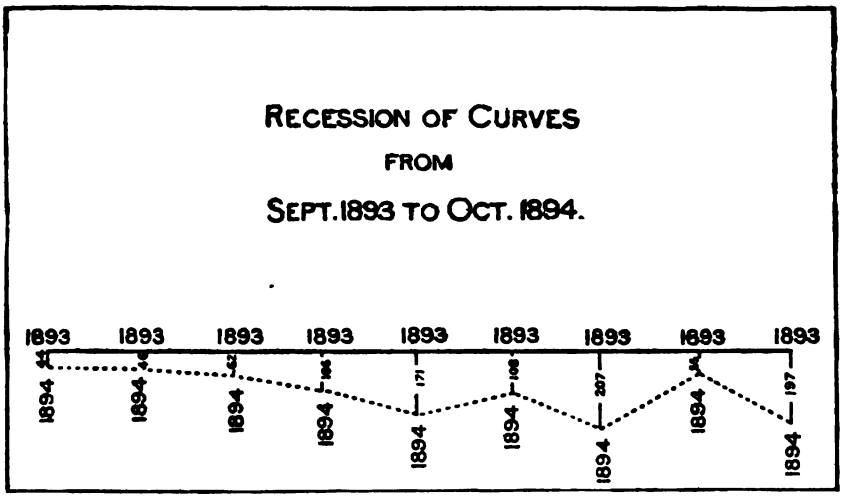
The following table gives the mean change over the whole area:

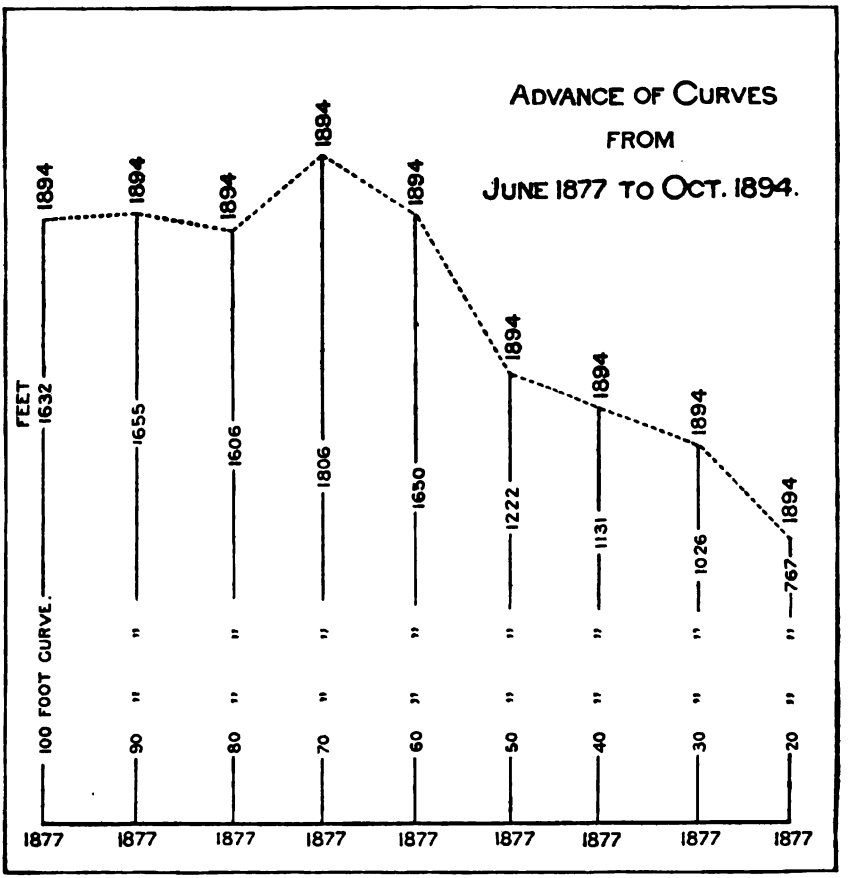
Mean change over whole area.

From—	To—	Deepened.	Shoaled.	From—	To—	Deepened.	Shoaled.
		Feet.	*Feet.*			*Feet.*	*Feet.*
1876	1877		.40	1886	1887		1.38
1877	1878	1.80		1887	1888		.31
1878	1879		2.56	1888	1889	1.23	
1879	1880	.12		1889	1890		1.11
1880	1881		2.38	1890	1891		2.70
1881	1882		1.30	1891	1892		1.59
1882	1883	.04		1892	1893		2.11
1883	1884		3.61	1893	1894	1.08	
1884	1885	1.16					
1885	1886		.12	1876	1894		14.14

LOSS OF THE BARK MARI VIZEU.

About midnight, January 5, 1895, the bark *Mari Viseu*, bound in and drawing 13 feet, was signaled by the pilot boat and, it is said, warned in every possible way that she was approaching danger. She was under full sail, and being driven by a strong wind it was with difficulty that the pilot boarded her, although he was not


RECESSION OF CURVES
FROM
SEPT. 1893 TO OCT. 1894.
1893
1894
171
197


ADVANCE OF CURVES
FROM
JUNE 1877 TO OCT. 1894.
FEET
100 FOOT CURVE.
1894
1632
1655
1606
1806
1650
1222
1131
1026
767
90
80
70
60
50
40
30
20
1877

in time to avert the disaster, as she struck soon after he boarded her. The port anchor was let go and she swung to it, heading out to sea; then the starboard one was let go and she dragged both until she reached a locality 1,500 feet south of the west jetty light, when, on the morning of the 7th, she began to leak badly and to settle into the sand. She was abandoned on that day and has proven a total loss.

She was a very old vessel, well insured, and without cargo.

THE NAVIGATION OF THE CHANNEL.

The channel throughout the entire length of South Pass was successfully navigated during the year, but two slight mishaps having occurred. Two steamers were aground about three hours each.

CONCLUSION.

During the year I was ably assisted by Mr. G. W. Lawes, who, on January 1, was promoted to the position of assistant engineer.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER, UPON WORK DONE TO EFFECT THE CLOSURE OF PASS A LOUTRE CREVASSE.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., March 16, 1895.

SIR: Under date of May 14, 1892, I reported to you relative to the work which had been done in an attempt to close a crevasse which had opened from Pass a Loutre into an arm of the Gulf known as Garden Island Bay. As stated, the work was abandoned January 14, 1892, and what remained of it at that time was destroyed during the high river periods of 1892 and 1893.

The ultimate closure of this crevasse was deemed so important a factor in the preservation of the requisite flow of water into South Pass that those interested in maintaining a channel of specified width and depth through that pass, and through the jetties at its mouth, decided to again attempt its closure. Accordingly, the services of Messrs. B. M. Harrod and H. B. Richardson, civil engineers, were secured, and the execution of the work according to a plan formulated by them was commenced July 29, 1893.

THE PLAN.

To encompass the deep water, which the current through the crevasse had caused to extend some distance down into the bay, by a dam which would be the shortest possible, and in the shoalest water, and at the same time reenforce so much of the south bank of Pass a Loutre as to insure against the effect of a possible giving away of that bank after the dam was completed, were the elements to be considered.

On sheet No. 1 is given the location of the dam. From shore to shore, on the lines laid down, the distance is 8,359 feet, being 3,480 feet from A to B, and 4,879 feet from B to D. For 4,300 feet the average depth of water was 9 feet, and over the remaining distance the depth varied from 1 to 4 feet.

The work consisted of two rows of piles 16 feet apart, the piles in each row being 8 feet apart, and projecting 9 feet above the water. The piles in each row were connected by a 4 by 8 inch timber driftbolted to them at a height of 6½ feet above the water, by bolts three-eighths of an inch in diameter and 10 inches long, and was made continuous by splices of the same material secured by screw bolts.

A continuous foundation mattress, built in the usual manner, 20 feet wide and 3 feet thick, was built suspended between the two rows of piling, and, when lowered onto the bottom, was still further compressed and pressed into the mud by placing upon it temporarily heavy weights which, after the mattress was secured in place, were lifted and moved from place to place by a floating derrick.

Pending the placing of loose willows upon the foundation mattress, by which means the dam was to be built above the surface of the water, when the whole would be securely anchored, the foundation mattress was held in place in the following manner, and as shown in fig. 1: A 3 by 12 inch plank 18 feet long, with a 1¼-inch hole near either end, was placed on top of the mattress, and made fast to it, at each bent of piles. The ends of two 4 by 6 scantlings were then prepared so as to enter these holes, leaving a shoulder to rest firmly upon the plank. When the mattress was firmly on the bottom, having been compressed as much as possible, the scantlings were cut off so that the upper ends would enter stirrups which were connected with the waling piece.

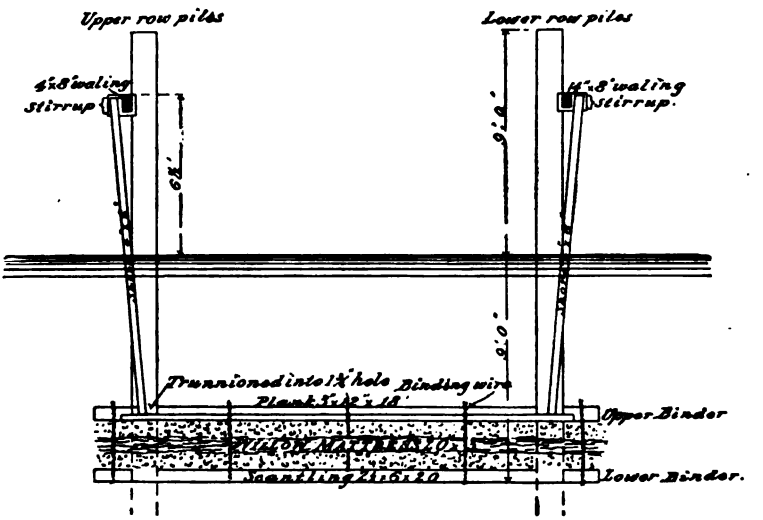
When the depth of water was such as not to permit of piles being driven, as in the vicinity of A, stakes were used to confine loose willows which were weighted with earth in sacks. Such of this work as was done is detailed on sheet No. 2.

After loose willows were placed upon the foundation mattress to such a height that after their compression the dam would be about 5 feet above the water, horizontal ties of 4 by 10 inch plank 20 feet long were placed underneath the waling timber and spiked to the piles in each bent. These, together with earth in sacks at some points, kept the willows in place and the former also prevented the two rows of piles from spreading apart.

PROGRESS OF THE WORK.

By October 1, 1893, the foundation mattress was in place from A to B, and for a distance of 1,300 feet from B toward D. On that date this vicinity was visited by a violent storm, the wind being from a southerly direction with a velocity at times as great as 70 miles per hour. Under ordinary circumstances the method by which the foundation mattress was held in place would have been sufficient—that is, until the work above it was completed—but when the work was subjected to the violence of that storm the shores upon which so much depended went down like the proverbial row of bricks, the mattress came to the surface and was more or less damaged.

Figure 1.



The floating plant, consisting of two quarter boats, two pile drivers, one derrick boat, and several barges, was driven ashore.

The storm entailed considerable loss financially, and the progress of the work was so retarded that it was impossible to bring it to that stage of completion which was anticipated and desired before the high water would necessitate its temporary discontinuance.

The work of floating the plant, except the quarter boats, having been accomplished, the construction was again commenced. The foundation mattress was adjusted and renewed in places, again sunk to the bottom, and secured in a permanent manner as shown in fig. 2.

Two 4 by 6 inch planks 18 feet long were placed across the mattress and on either side of the piles in each bent. On top of these, at right angles to them, against the piles and between them, were spiked pieces of the same material 3 feet long. These received the ends of 4 by 4 inch shores which, when the mattress was firmly bedded, were securely spiked to the piles.

The work progressed favorably, and was temporarily discontinued April 14, 1894, pending the return of the river to a low stage, when it could be done to better advantage. On this date the work was practically completed from A to B, and for 1,150 feet from B toward D, and was 5 feet above the surface of the water.

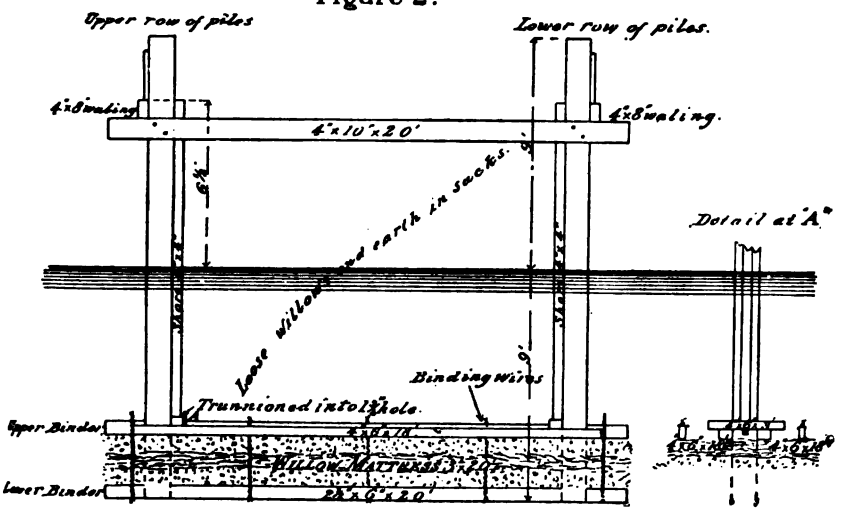
During the high river a careful watch was kept to detect places where underscour would occur—several such places were stopped by putting in sacks filled with earth.

At a point 1,060 feet westward from B the foundation gave away and, together with the piling, was washed out for a distance of 170 feet. In consequence of this break the depth of water was increased to 20 feet for a distance of 440 feet, and for 280 feet of this distance the depth was 25 feet.

A survey made in June and July, 1894, showed the beneficial effect of the work in place in causing a shoaling over the deep-water area; at the same time, however, the shoaler area to the westward was deepened in consequence of the flow of water deflected across it by the work from A to B.

On September 1, 1894, work was resumed, it having been decided to carry the work to the westward by the use of sheet piling. This work was commenced at a point, H, which is on the line B D, and 575 feet from B, from which point it was built 403 feet on a line making an angle of about 80° with B D. At a point, I, 380 feet from H, it was built for a distance of 224 feet on the line from I to D which is about at right angles to H I. This offset from the line B D was made rather than to build across the deep water which the break in the work on that line had caused.

Figure 2.



The piles used were 8 by 12 inches and 35, 40, 50, and 55 feet long, to one edge of which pieces 1¼ inches thick were spiked, which formed a dovetail groove, and to the other edge a piece which formed a corresponding tongue. Every third pile was driven to the surface of the water, the intermediate ones being 4½ feet above the surface, and at their upper ends they were confined between two 8 by 8 inch waling pieces held by bolts through them and the piles, at intervals of 3½ feet. (See fig. 3.)

Some willows weighted with earth in sacks were placed between the piles at the west end, D, of the dam.

During October 7 and 8, 1894, another violent storm swept over this locality. On October 5, 6, and 7 information was received from the Signal Service Bureau at Washington that there was a dangerous storm central to the southward of Port Eads. At midnight on the 4th the wind suddenly increased to 22 miles per hour, the general direction being northeast. This force was maintained quite uniformly until 3 a. m. on the 6th, when the velocity was 26 miles per hour, and varied from that to 32 miles until 11 a. m. on the 7th, when it began to increase rapidly, attaining a velocity of 42 miles at 4 p. m., 50 miles at 10 p. m., 64 miles at midnight, and at 3 a. m. on the morning of the 8th the force was 77 miles. At 4.30 a. m. (on the 8th) the wind backed to the north, and the storm continued with great violence. At 10 a. m. it changed to northwest and slowly decreased in force.

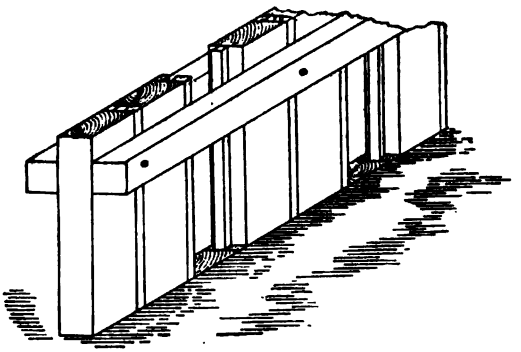
A heavy rain fell during most of the time from 5 p. m. on the 7th to 9 a. m. on the 8th. Lowest barometer, 29.38 at 8 a. m. on the 8th. The greatest wind force of which record was obtained was 84 miles per hour.

About 50 feet of sheet piling was washed out from the west end of that work, and in four places (numbered 1, 2, 3, and 4, on sheet No. 1), within a reach of 800 feet, the work from A to B gave away and 350 feet of it was destroyed.

Considering the violence of the storm, the damage sustained by the work was not great, but it was sufficient to establish the fact that the work already completed was not sufficiently reliable, and that under the circumstances it would be unwise to continue with further work. The project was therefore permanently abandoned.

The condition of the work at the time it was discontinued is given on sheet No. 1.

Figure 3.



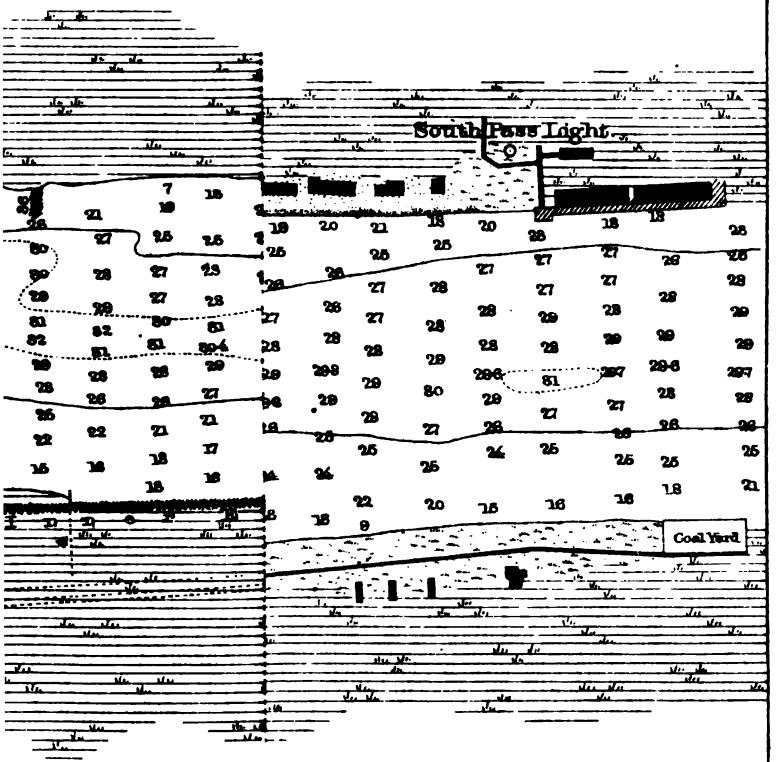
The following materials were used in the construction of this work:

Pine piles	linear feet	99,749
Willows	cords	17,621
Pine lumber	feet, B. M.	338,436
Manila rope	pounds	2,655
Galvanized wire	do	10,033
Washers	do	1,874
Driftbolts	do	4,206
Screw bolts		2,000
Carriage bolts		100
Machine bolts		400
Wrought spikes	kegs	22
Nails	do	10
Sacks		32,300
Sheet piling (8 by 12 inch)	linear feet	21,475
Waling timber (8 by 8 inch)	do	1,320
Lumber for dovetail joints (1⅞ by 2½ inch)	do	51,035
Screwbolts (⅞ by 26 inch)		208
Screwbolts (⅞ by 18 inch)		18

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers.



r the year ending June 30, 1895.

James D. Lacey

Major, Corps of Eng'rs, U.S.A.

APPENDIX R.

IMPROVEMENT OF RIVERS AND HARBORS IN SOUTHERN LOUISIANA AND EASTERN TEXAS.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chefuncte River and Bogue Falia, Louisiana.
2. Tickfaw River and its tributaries, Louisiana.
3. Amite River and Bayou Manchac, Louisiana.
4. Bayou Lafourche, Louisiana.
5. Bayou Terrebonne, Louisiana.
6. Bayou Plaquemine, Grand River, and Pigeon bayous, Louisiana.
7. Bayou Courtableau, Louisiana.
8. Bayou Teche, Louisiana.
9. Channel, bay, and passes of Bayou Vermilion, Louisiana.
10. Mermentau River and tributaries, Louisiana.
11. Mouth and passes of Calcasieu River, Louisiana.
12. Harbor of Sabine Pass, Tex.
13. Sabine River, Texas.
14. Neches River, Texas.
15. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS.

16. Bayou Bonfuca, in St. Tammany Parish, La.
17. Chefuncte River and Bogue Falia, Louisiana.
18. Tickfaw River and tributaries, Louisiana.
19. Bayou Teche, Louisiana.
20. Channel through Sabine Lake, Texas.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 5, 1895.

GENERAL: I have the honor to transmit herewith annual reports * * * upon works of river and harbor improvement at present under my charge for the fiscal year ending June 30, 1895.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

R 1.

IMPROVEMENT OF CHEFUNCTE (TCHEFUNCTE) RIVER AND BOGUE FALIA, LOUISIANA.

The project for the improvement of this river was adopted in 1880, and contemplated the removal of obstructions in the channel, such as snags, logs, and overhanging trees, and the dredging of the bar at the river's mouth.

With the two appropriations made in 1881 and 1882, of $1,500 each, obstructions below Covington were removed, and part of the unexpended balance was used for the construction of a working plant for improving the bar at the mouth and part of the construction of 820 feet of breakwater.

August 5, 1886, Congress made an appropriation of $2,500 for this work, and in 1887 channels were cut through the bars between Covington and Old Landing 5 feet deep and 30 to 60 feet wide, giving better navigation for schooners between these places.

The original estimated cost of improving this river was $5,460, the greater portion of which was for dredging the bar at its mouth.

It was thought, however, that a dredged channel over this bar could not be maintained without protecting works, which would cost considerably more than the dredging. Major Stickney, who had charge of this work, caused a reexamination to be made in 1884, and in his report in the Annual Report of the Chief of Engineers for 1884, volume 2, page 1269, he reports the river in good order except the bar at its mouth, and suggests as a method of improving this to build a jetty or breakwater 2,500 feet long across the bar into the comparatively deep water of Lake Pontchartrain, and then to dredge the channel through the bar, in the hope that the jetty would prevent, or at all events greatly retard, the refilling of the cut with sand.

Under the appropriation of $1,000, made September 19, 1890, the work of removing obstructions in the channel was commenced in October, 1891, using the snagging plant which had shortly before ceased operations on the Tickfaw River. This plant consists of a quarter boat, for the accommodation of the working party and a flat boat supplied with a derrick and steam hoisting engine for lifting out snags, and small boats, tools, etc., ordinarily used for this class of work.

Snags, logs, and impending trees were removed from the channel of the river from Madisonville to Old Landing, and from the latter place to Covington, on the Bogue Falia, as far as the funds on hand would permit. The principal obstructions removed from the channel during that year were: 161 snags, 82 overhanging trees, 61 landslide trees, 58 stumps, 44 logs, and 29 tree tops. The work was discontinued November 30, 1891.

In 1892 Congress appropriated $1,000 for maintenance, but aside from making extensive repairs to the snagging plant used on the improvement of these streams, no work was done.

The total amount expended on the improvement to June 30, 1895, was $8,306.31.

The river then had a navigable depth of 5 feet to Old Landing, and from there to Covington the Bogue Falia was navigable for the lighter-draft schooners.

The project under the appropriation of $1,000 for maintenance, made August 17, 1894, was to improve the navigation of these streams to the town of Covington, the only obstructions to which being a few bars

with not over 3 feet depth over them. Accordingly, contract was entered into and approved in November, 1894, for the expenditure of available funds in dredging through the bars below Covington to a depth of 6 feet and a width of about 60 feet.

This work was commenced by the contractor February 4 and completed February 15, 1895. Some 3,655 cubic yards of material was dredged from these bars.

Navigation for steamers drawing 5 feet is now available to Covington, about 14 miles from the mouth of the river.

The bar at the mouth of the river has a depth of about 5 feet at low water.

The amount expended for this work in fiscal year ending June 30, 1895, was $1,340.92.

About $1,000 will be required each year to keep the rivers free of obstructions.

Abstract of appropriations for improving Chefuncte (Tchefuncte) River and Bogue Falia, Louisiana.

By act of Congress—	
Approved March 3, 1881	$1,500
Passed August 2, 1882	1,500
By act of Congress approved—	
August 5, 1886	2,500
September 19, 1890	1,000
July 13, 1892	1,000
By act of Congress of August 17, 1894	1,000
Total	8,500

Money statement.

July 1, 1894, balance unexpended	$534.61
Amount appropriated by act of August 17, 1894	1,000.00
	1,534.61
June 30, 1895, amount expended during fiscal year	1,340.92
ly 1, 1895, balance unexpended	193.69
Amount that can be profitably expended in fiscal year ending June 30, 1897	1,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals received for furnishing a dredge for improving Chefuncte River and Bogue Falia, Louisiana, opened at New Orleans, La., November 9, 1894, by Maj. James B. Quinn, Corps of Engineers.

Name and address of bidder.	Price bid per day.
De Witt Dilworth, New Orleans, La	$125

Contract awarded to the only bidder, with the approval of the Chief of Engineers Contract dated November 24, 1894, and approved November 30, 1894. Work to commence within 60 days after approval of contract and be completed on or before March 31, 1895.

taries, the Natalbany, Blood, and Pontchatoula rivers, by removing obstructions to navigation, such as snags, logs, stumps, and overhanging trees.

In 1881 $2,000 was appropriated with which to commence work. The work under this appropriation was done by contract in 1882, and 16 miles of the Tickfaw was cleaned out.

In 1882 Congress appropriated $2,000 more. This was expended partly in building plant, and the work of cleaning out the stream was done with this plant and hired labor. The result was a good navigable channel 9 miles above the previous head of navigation on the Tickfaw.

In 1886 an appropriation of $2,000 was made, the funds to be used in cleaning out the navigable branches of the Tickfaw. In the latter part of 1886 and early part of 1887 work was resumed with the Government plant and hired labor, and the branches cleaned to the head of navigation.

In 1888 an appropriation of $1,000 was made for improving the Tickfaw and its navigable tributaries. The latter being in good condition, the snagging plant commenced work on the river itself in May, 1889, removing the obstructions that had reformed since 1887, and worked upstream to within 1 mile of the Chapman Place, where operations ceased.

In 1890 $1,000 was appropriated for continuing the improvement. In September, 1891, work was commenced with the Government snagging plant and hired labor. The obstructions which had reformed since 1889, such as snags, logs, overhanging trees, etc., were removed from the Tickfaw, Natalbany, and Blood rivers, the latter being cleared to the head of navigation. About 39 miles of channel had been improved when the work ceased, October 12, 1891.

On July 13, 1892, an appropriation of $1,000 was made for maintenance. The plant, which had shortly before been used on the Amite River, was towed to the Tickfaw, and work was commenced at the mouth of the river on December 20, 1892, and was carried on upstream, resulting in the improvement of 30 miles of channel by the removal of 382 obstructions. Operations were discontinued January 20, 1893, and the plant was laid up at Springfield, La., and placed in charge of a watchman.

Extensive repairs to the snagging plant were completed in November, 1892. This plant consists of a quarter boat for the working crew, a flat supplied with a derrick and steam hoisting engine for pulling out snags, and small boats, tools, etc., ordinarily used for this kind of work.

Under the appropriation of $1,000 made August 17, 1894, for maintenance, the snagging plant was again thoroughly repaired and the work of removing obstructions which had reformed was commenced in December of that year and discontinued on February 8, 1895, when the plant was removed to the Amite River for work there. Some 1,568 obstructions, consisting of sunken logs and trees, stumps, snags, overhanging trees, etc., were removed in a distance of 3½ miles. The improvement was made from Talbots Field to Whitmore Island, on the Tickfaw River. After completion of work on the Amite River the plant was tied up at Wadesboro and placed in charge of a watchman.

The streams are now in fair condition, but as obstructions will continue to form, the improvement is not permanent, and it is estimated that $1,000 will be required annually to keep the navigable channel in condition.

The total amount expended on the improvement of these streams to June 30, 1895, was $9,862.81.

Abstract of appropriations for improving Tickfaw River and its tributaries, Louisiana.

By act of Congress—	
Approved March 3, 1881	$2,000
Passed August 2, 1882	2,000
Approved August 5, 1886	2,000
Of August 11, 1888	1,000
Approved September 19, 1890	1,000
Approved July 13, 1892	1,000
Passed August 17, 1894	1,000
Total	10,000

Money statement.

July 1, 1894, balance unexpended	$173.70
Amount appropriated by act of August 17, 1894	1,000.00
	1,173.70
June 30, 1895, amount expended during fiscal year	1,036.51
July 1, 1895, balance unexpended	137.19
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	1,000.00

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	5
Net tonnage, registered	337
Trips made	121
Gross tonnage, 121 trips	15,534
Schooners	35
Net tonnage, registered	697
Trips made	158
Gross tonnage, 158 trips	60,524
Total vessels	40
Total net tonnage	1,034
Total trips	279
Total gross tonnage	76,058

Draft of heaviest steamer, 6 feet. Draft of heaviest schooner, light, 3.5 feet; loaded, 6.4 feet.

No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Wood	2,452	$6,908	5,495	$7,850
Lumber	33,370	120,899	13,864	108,738
Brick	711	2,212	597	1,673
Cotton	155	21,630	182	21,120
Miscellaneous	45	2,025	61	1,560
Total	36,733	153,674	20,199	140,941
RECEIPTS.				
Merchandise	3,270	98,100	3,185	79,625
Grand total	40,003	251,774	23,384	220,566

Comparative statement of receipts and shipments for four years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1892	11,407	$102,116	1894	40,003	$251,774
1893	13,994	169,643	1895	23,384	220,566

R 3.

IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

The original project for the improvement of this river was adopted in 1880, which contemplated a channel 5 feet in depth as far upstream as appropriations would permit, the main part of the work to be done above the mouth of Bayou Manchac.

In 1883, owing to the unsatisfactory manner of doing the work by contract, the project was amended so as to provide for the removal of obstructions below the Manchac by the Government plant and hired labor, and resulted in a satisfactory improvement of about 8 miles of the river.

In 1886, under the appropriation of $2,000, work with Government plant and hired labor was resumed, and the logs and snags removed from about 5 miles of river below the mouth of the Bayou Manchac, leaving the Amite River in good navigable condition.

In 1888 $5,000 was appropriated, with the stipulation that half of this sum might be used in improving Bayou Manchac, and in November, 1888, work with the Government plant and hired labor was commenced in this bayou, working up from its mouth to Hereford Landing, leaving the Manchac in good condition up to that point. The plant was then taken back to the Amite River, and from it removed the snags, logs, and impending trees which obstructed the channel.

In 1890 $3,800 was appropriated for the completion of the old project, the money, however, to be applied to the Amite or Manchac in such proportions as the engineers might deem best. Work was resumed in October, 1890, with the Government plant at Hope Villa, on the Manchac, and the bayou cleaned up for a distance of about 3 miles, when the plant turned back and, commencing at Wards Creek, worked downstream to the Amite River.

Snags, logs, and impending trees were removed from the Bayou Manchac between its mouth and Hope Villa, and from the river between its mouth and the junction with Bayou Manchac.

In 1892 $2,500 was appropriated for maintenance, $1,000 of which was to be used to construct a turning basin for boats at or near the mouth of Wards Creek, on Bayou Manchac. As the dredging of a turning basin at this place would cost more than the sum stated, my recommendation that this amount be held for further increase was approved.

Authority was obtained and the snagging plant thoroughly repaired. This plant consists of a quarter boat for the working party, a derrick boat with steam hoisting engine for removing obstructions, and small boat, tools, etc., ordinarily used for this class of work.

Work was commenced November 17, 1892, under the appropriation of that year, at Wards Creek, on Bayou Manchac, and was carried on to Port Vincent, on the Amite River, improving about 20 miles of channel by the removal of 381 obstructions. The work was discontinued

December 15, 1892, and the plant towed to the Tickfaw River for work on that stream.

The act of August 17, 1894, appropriated $2,500 for maintenance, the approved project under which contemplated the removal of obstructions from the river and bayou, and, inasmuch as no increase had been made, the expenditure of the $1,000 appropriated in 1892 in dredging the turning basin.

Accordingly work on the turning basin was commenced, under contract, January 24, and completed February 1, 1895. Some 4,080 cubic yards of material was excavated and numerous logs removed.

The snagging plant was again thoroughly repaired, and, upon completion of the work on the Tickfaw River, it was removed to the mouth of Wards Creek, on Bayou Manchac, where operations were commenced February 18, 1895. The work was carried on down to the town of Clio, on the Amite River, a distance of about 22 miles, where operations ceased on May 31, 1895.

During this time some 5,019 obstructions were removed, consisting of 325 landslide trees, 113 sunken logs and trees, 150 snags, 236 clusters of brush, 2,343 overhanging trees, and the deadening of 1,852 trees.

This improvement gives much relief to the commerce of these streams and has added an average of about 3 feet to the available depth of the channel and a greatly increased width.

Stumps and logs are continually getting into the channel, forming obstructions, and therefore the improvement is not permanent. About $2,500 will be required annually to keep these streams in navigable condition.

The amount expended on the improvement of these streams to June 30, 1895, was $28,279.32.

Abstract of appropriations for improving Amite River and Bayou Manchac, Louisiana.

By act of Congress approved—	
June 14, 1880	$8,000
March 3, 1881	5,000
August 5, 1886	2,000
By act of Congress of August 11, 1888	5,000
By act of Congress approved—	
September 19, 1890	3,800
July 13, 1892	2,500
By act of Congress of August 17, 1894	2,500
Total	28,800

Money statement.

July 1, 1894, balance unexpended	$1,211.00	
Amount appropriated by act of August 17, 1894	2,500.00	
		3,711.00
June 30, 1895, amount expended during fiscal year		3,190.32
July 1, 1895, balance unexpended		520.68
July 1, 1895, outstanding liabilities		8.33
July 1, 1895, balance available		512.35

Amount that can be profitably expended in fiscal year ending June 30, 1897 2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals received for furnishing a dredge for dredging a turning basin for boats in connection with the improvement of the Amite River and Bayou Manchac, Louisiana, opened at New Orleans, La., November 5, 1894, by Maj. James B. Quinn, Corps of Engineers.

Name and address of bidder.	Price bid per day.
De Witt Dilworth, New Orleans, La	$125

Contract entered into with the only bidder with the approval of the Chief of Engineers. Contract dated November 21, 1894, and approved November 30, 1894. Work to be commenced sixty days after approval of contract, and completed on or before February 28, 1895.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	7
Net tonnage, registered	400
Trips made	618
Gross tonnage, 618 trips	247,200
Schooners	21
Net tonnage, registered	382
Trips made	51
Gross tonnage, 51 trips	19,482
Barges	3
Net tonnage	75
Trips made	183
Gross tonnage, 183 trips	13,725
Total vessels	31
Total net tonnage	857
Total trips	852
Total gross tonnage	280,407

Draft of heaviest vessel, light, 6.6 feet; loaded, 7 feet.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber, shingles, and laths	139,427	$418,947	32,303	$223,456
Wood	4,018	8,376	3,676	5,973
Staves	448	2,250	522	18,118
Sugar and molasses	95	7,193	251	9,373
Cotton and cotton seed	964	97,059	1,503	111,726
Miscellaneous	50	4,480	65	5,995
Total	145,002	538,305	38,320	374,641
RECEIPTS.				
Merchandise	12,900	258,000	4,663	116,575
Grand total	157,902	796,305	42,983	491,216

Comparative statement of receipts and shipments for six years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1890	84,295	$291,967	1893	22,099	$346,257
1891	17,792	300,963	1894	157,902	796,305
1892	18,530	334,061	1895	42,983	491,216

R 4.

IMPROVEMENT OF BAYOU LAFOURCHE, LOUISIANA.

In 1879 a project was approved for removing the obstructions to navigation in the bayou, such as snags, wrecks, raft heaps, and impending trees. Work was carried on under this project from 1881 until 1883, when the plant was laid up at Lockport after clearing the bayou a distance of 30 miles below that point.

In 1884 a project was approved for continuing the snagging operations on down beyond the place where work had ceased in 1883, and accordingly work was resumed in September, 1884, and continued to January, 1885, when operations were suspended on account of high water. The plant was subsequently removed to other places.

Beyond surveys and examinations nothing further was done until 1888, when Congress appropriated for "improving Bayou Lafourche, Louisiana, pursuant to the project of Lieut. O. T. Crosby, Corps of Engineers, dated June 11, 1886, $50,000, including immediate dredging to secure low-water navigation."

During high water Bayou Lafourche is navigable by the largest steamboats, but during extreme low water navigation is sometimes entirely suspended for flatboats drawing over 2 feet of water.

The project referred to in the foregoing act was to place a lock in the Mississippi end of the bayou, converting the bayou into a slack-water stream, and then dredge a channel 75 feet wide and 5 feet deep at mean low water of the Gulf throughout its length.

The act also provided for immediate dredging, and since the bar at the river end of the bayou had shut out navigation in 1887, it was proposed to dredge a channel through this bar, the channel to have a depth of 4 feet below mean low water of the gulf and a width of 60 feet. This dredging was done by contract, and admitted sufficient water to the bayou to reestablish flatboat navigation, which had been suspended a day or two while the cut was being made.

It having been ascertained that about 150,000 cubic yards of material would have to be dredged from the bayou to secure 2 feet depth for flatboat navigation, bids were opened June 10, 1889, for dredging this amount, but the price bid was deemed too high, and the bid was rejected. Work was then begun by a hired dredge, and continued until high water interfered.

The channel had been carried a distance of about 2 miles from the mouth, and had a depth of 2 to 3 feet at mean low water of the Gulf. Upon commencing this dredging it was found that the channel through the bar at the head of the bayou had shoaled so as to require redredging, and much of the channel work had to be gone over several times, owing to the caving of the sides of the cut. On September 15, 1890, dredging was resumed.

The dredge had, as formerly, to reopen the channel through the bar at the head of the bayou and redredge much of the work previously gone over.

The dredging has been continued since during the low-water season of each year, and in 1892, with the use of an additional dredge, the work was carried on from Donaldsonville down to the mouth of the bayou, improving about 100 miles of channel.

During the low-water season of 1893 operations were continued between Donaldsonville and a point 2 miles above Lockport.

Work during the past year commenced July 5, 1894, just outside of the mouth of the bayou and was carried on to a point about 33 miles below Donaldsonville, La., when operations were interrupted by high water and suspended on April 5, 1895. During this time 116,479 cubic yards of material, 340 snags, 161 stumps, 7 submerged logs, and 16 wrecks were removed from the channel, making flatboat navigation available during the entire low-water season.

As the silting up of the dredged channel takes place with the recurrence of high water each year, the improvement by dredging is slow and unsatisfactory. The construction of a lock at Donaldsonville will almost entirely overcome this difficulty and render the navigation of the bayou safe and certain under all conditions of the tide in the Mississippi River.

The cost of a lock at Donaldsonville was estimated by Lieutenant Crosby to be about $450,000. With this lock completed, whatever dredging was done in the bayou thereafter would be practically permanent, and a moderate annual expenditure would maintain satisfactory navigation, hardly possible to secure with any amount of money under the present conditions.

There has been expended on the improvement of this bayou to June 30, 1895, the sum of $141,930.80.

Owing to the unusually low and protracted stage of water in the Mississippi River and the shoals at the entrance to the bayou, and inside and below, there were but 123 days of steamboat navigation this year, flatboats being the only means of transportation during the balance of the year, of which there are 55 regularly employed. Excluding the coal which comes in original package from Pittsburg, some 1,900 miles, the steamboats handled but 52,648 tons of freight, 126,359 tons being carried by flatboats.

When the steamboats are able to enter the bayou, freight rates are lowest, being much higher when steamboats have to transfer to flatboats. The rates are highest when flatboats can not connect with the steamboats, which was the case previous to the last dredging done in the bayou. When steamboats are able to run through, which is the quicker, cheaper, and more satisfactory means of transportation, their withdrawal under such circumstances involves great inconvenience and additional expense; therefore, a strong popular sentiment exists for the construction of the proposed locks at the entrance to the bayou, which, when completed, will, within a few years, cause a saving to the producers, carriers, and consumers equal to the total estimated cost of the locks.

On account of low water there were shipped via Bayou Lafourche this year but 84,600 tons of coal as against 122,812 tons last year.

Abstract of appropriations for improving Bayou Lafourche, Louisiana.

By act of Congress approved—	
June 18, 1878	$10,000
March 3, 1879	10,000
June 14, 1880	5,000
July 5, 1884	5,000
By act of Congress of August 11, 1888	50,000
By act of Congress approved—	
September 19, 1890	50,000
July 13, 1892	50,000
By act of Congress of August 17, 1894	40,000
Total	220,000

Money statement.

July 1, 1894, balance unexpended	$60,020.37
Amount appropriated by act of August 17, 1894	40,000.00
	100,020.37
June 30, 1895, amount expended during fiscal year	21,951.17
July 1, 1895, balance unexpended	78,069.20
July 1, 1895, outstanding liabilities	190.00
July 1, 1895, balance available	77,879.20
Amount (estimated) required for completion of existing project	310,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals received for furnishing a dredge for improving Bayou Lafourche, Louisiana, opened at New Orleans, La., June 28, 1895, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Price per day for dredging.
1	Rittenhouse Moore Dredging Co., Mobile, Ala	$74.00
2	J. B. Donally, New Orleans, La	70.00
3	Dodge Dredge Co., Limited, Napoleonville, La	73.00
4	Henry Camors, New Orleans, La	66.50
5	E. A. Burris, New Orleans, La	64.00

Recommendation was made to the Chief of Engineers that the lowest bid, that of Mr. E. A. Burris, be accepted.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	26
Net tonnage, registered	3,363
Trips	608
Gross tonnage, 608 trips	2,044,708
Luggers	13
Net tonnage, registered	88
Trips	25
Gross tonnage, 25 trips	2,200
Barges	113
Trips	121
Gross tonnage, 121 trips	93,990
Total vessels	152
Total tonnage	97,441
Total trips	754
Total gross tonnage	2,140,898

Draft of heaviest steamer, light, 3 feet; loaded, 9 feet. Draft of largest barge, light, 18 inches; loaded, 8 feet.

Of the steamers, 7 were regularly employed; the other 19 were transient.

Not included in the above are 55 flatboats which were exclusively engaged in carrying freight of all kinds on the bayou to and from the Southern Pacific Railroad at Lafourche Crossing, the Texas and Pacific Railroad at Donaldsonville, and the steamboats at the entrance to the bayou, when the water was too low to permit of the entrance of steamboats.

The aggregate carrying capacity of these 55 flatboats is equal to 6,502 tons of freight.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar	46,510	$5,007,858	88,376	$6,823,122
Molasses	23,145	585,514	31,332	569,688
Rice	3,318	105,897	2,320	83,294
Potatoes and onions	6,089	166,822	5,779	115,587
Eggs	162	15,367	156	23,395
Moss	213	8,736	168	6,732
Pecans	1	195	30	4,848
Miscellaneous	352	29,208	214	10,496
Total	79,730	5,919,597	128,375	7,637,162
RECEIPTS.				
Miscellaneous	71,144	2,578,970	50,632	1,314,792
Coal	122,812	344,375	84,600	272,600
Total	273,686	8,842,942	263,607	9,224,554

Comparative statement of receipts and shipments for six years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1890	200,746	$5,709,382	1893	212,476	$7,422,285
1891	217,273	8,244,225	1894	273,686	8,842,942
1892	171,855	5,660,622	1895	263,607	9,224,554

R 5.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

Previous to the commencement of the improvement of the Bayou Terrebonne it was a little better than a drainage ditch in places.

The project adopted for the improvement of this bayou contemplated the dredging of a channel 4 feet deep at mean low water of the Gulf to Houma, and with the appropriation of $10,000, made in 1880, the work of dredging was commenced in that year and continued until December 17, 1887, when the channel was completed to the railroad depot at Houma, where a turning basin was dug.

The improvement enables planters on the bayou to float their produce to Houma, the nearest railroad station, or else ship by boat direct to New Orleans by way of connecting bayous and canals.

It is doubtful if the improvement can be made permanent, as more or less silt finds its way into the bayou, causing shoals to form, which will require removal from time to time.

The channel dredged by the Government has stood very well, but will require some attention in the near future to keep it in good condition.

The estimated cost of the improvement was $38,800. The completion of the project has cost $38,642.60.

The amount expended during the year just closed was $1,077.84, which was applied on repairs to the dredge belonging to this appropriation.

The commercial statistics for the year ending May 31, 1893, are appended.

Abstract of appropriations for improving Bayou Terrebonne, Louisiana.

By act of Congress approved—	
June 14, 1880	$10,00
March 3, 1881	8,80
By act of Congress—	
Passed August 2, 1882	7,00
Approved August 5, 1886	10,00
Of August 11, 1888	3,00
Total	38,80

Money statement.

July 1, 1894, balance unexpended	$1,236.
June 30, 1895, amount expended during fiscal year	1,077.
July 1, 1895, balance unexpended	158.
Amount that can be profitably expended in fiscal year ending June 30, 1897	5,000.
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

During the year ending May 31, 1895, there were no steamers running on Bay Terrebonne, and no other vessels were regularly employed in carrying freight.

Steamers	
Trips	
Tonnage	3,3
Barges	
Trips	
Tonnage	2,2
Total vessels	
Total trips	
Total tonnage	5,5

During the fiscal years 1891 and 1892 there were no steamboats running to N Orleans direct, owing to the difficulties and expense of navigation, but during t year ending May 31, 1893, merchants and planters secured at their own cost mea of transportation with the above results.

Receipts and shipments for two years.

[From June 1, 1892, to May 31, 1893.]

Articles.	Tons.	Valu
Sugar and molasses	1,189	$129,
Miscellaneous freight	121	5,
Coal	1,700	6,
Total	3,010	142,

R 6.

IMPROVEMENT OF BAYOU PLAQUEMINE, GRAND RIVER, AND PIGE BAYOUS, LOUISIANA.

Prior to 1867 or 1868 Bayou Plaquemine was navigable by the la est steamboats, but sometime during the years mentioned the pol jury of Iberville Parish, without warrant of law, caused a dike to built across the bayou, shutting out the water of the Mississippi Riv

Steamers which had used the Plaquemine route to the Teche and Courtableau were thus forced to go by way of the mouth of the Red River and Atchafalaya, and at low water, owing to the closing of the mouth of Red River, are compelled to cease running.

The opening of this bayou is therefore of great importance, as, if opened, it would furnish communication at all seasons with the navigable waters of northern and western Louisiana, which are stated by good authority to have an available length of 4,300 miles.

In 1885 a project for the improvement of this bayou, by building a lock to connect it with the Mississippi River, and clearing out the channel so as to give a depth of 6 feet at mean low water of the Gulf, was presented.

This improvement was estimated to cost $1,708,250.

In 1888 $100,000 was appropriated "for securing a navigable channel 60 feet wide and 6 feet in depth from deep water up to the Plaquemine Dike, and for securing the mouth of the bayou from further caving."

As there was no plant at the disposal of this office for the construction of dikes, etc., $75,000 of this appropriation was allotted for construction of bank protections and turned over to the officer in charge of the fourth district of the Mississippi River in May, 1889.

With the remainder of the funds dredging was commenced June 4, 1889, at a point about 5 miles below the town of Plaquemine, the work being done with a dredge belonging to the United States and hired labor.

Owing to the railroad bridge not being a draw bridge, it was not possible to continue the dredging up to the Plaquemine dike, as specified in the act of appropriation. The project was accordingly modified so as to stop dredging when the railroad bridge was reached, and when that was accomplished the dredge was turned back and worked down to a point one-half mile below, when work was discontinued and the plant laid up and placed in charge of a watchman.

August 20, 1892, while in charge of a watchman, the dredge boat sank at her moorings. Measures were at once taken to raise the boat, and on September 5, she was floated. An inspection showed the necessity for a general overhauling, and, authority therefor having been obtained, repairs were commenced at once and finished November 20, 1892.

From this date until January 1, 1893, the boat was employed in improving the bayou, removing all obstructions for a distance of 3½ miles.

The river and harbor act of August 17, 1894, appropriated $110,000 for continuing the improvement, $10,000 of which was allotted for removing obstructions in Grand River and Pigeon bayous.

The approved project for the expenditure of this money, together with balance from old appropriation, contemplated the continuance of dredging in Bayou Plaquemine, the construction of a cofferdam and foundation for the proposed lock, and removing obstructions in Grand River and Pigeon bayous, the sum of $20,000 being reserved for repairs to the river bank protection.

Dredging operations in Bayou Plaquemine were again resumed on January 11, 1894, and continued until November 5 of that year, when the dredge was removed for work on Grand River and Pigeon bayous. The work was commenced at the railroad bridge opposite Plaquemine and carried up to the Plaquemine Dike.

The total amount of material removed from Bayou Plaquemine since the commencement of the improvement is 355,921 cubic yards, 2,081

logs, snags, and stumps, many of the latter requiring the use of dynamite to break them up.

The character of the material dredged was such that it was necessary to construct bulkheads to prevent its slipping back into the channel.

GRAND RIVER AND PIGEON BAYOUS.

The river and harbor act of July 13, 1892, provided that these streams, "forming part of the Bayou Plaquemine route," should be improved, and January 1, 1893, the dredge boat was ordered to Grand River for that purpose.

Work was continued between bayous Sorrel and Pigeon until March 22, 1893, when the rapid rise of the river forced its discontinuance in upper Grand River, and the dredge was consequently ordered to Flat Lake, on the lower end of this river, with a view of opening up the route to the Teche and Atchafalaya via Grand River.

The operations in the Grand River resulted in the removal of 13,826 cubic yards of material, 5,525 overhanging trees, 667 logs, 16 snags, and 55 stumps.

During the year 1893 obstructions were removed from the mouth of Bayou Sorrel, on Grand River, down the latter stream and through Big Pigeon Bayou to Grand Lake, a distance of 30 miles. The obstructions removed consisted of 1,386 overhanging trees, 98 sunken logs, and 4½ miles of raft. This work was commenced on August 17, and completed October 2, 1893.

The act of August 17, 1894, provided $10,000 to be used, in the discretion of the Secretary of War, in removing obstructions from these bayous.

Authority having been obtained for the hire of the dredge at work on Bayou Plaquemine, she was removed, upon completion of work there, November 5, 1894, to the juncture of Sorrel and Grand River bayous. The work was carried on from this point to the mouth of Little Pigeon Bayou, via Grand River and Big Pigeon bayous, practically the same route gone over in 1893. The funds being nearly exhausted, work was discontinued here on January 3, 1895, before completing the channel through the bar, which is composed of very hard material, at the entrance to Grand Lake.

It being greatly desired by those interested to complete the clearing of the streams before the recurrence of high water, and also in time to facilitate the marketing of the crops of 1894, authority was obtained, and the dredge operated double time.

During this time 32,535 cubic yards of material, 133 stumps, 495 sunken logs, and 36 overhanging trees were removed. The distance improved was about 30 miles.

The completion of this work opens a competing steamboat route in connection with the Texas and Pacific Railway at Plaquemine, and has already caused a reduction of freight rates from the Teche of 33⅓ per cent.

In order to keep this route open, $10,000 for further work is recommended for the coming year.

The total amount thus far expended on the improvement of this route is $18,698.91.

PLAQUEMINE LOCK.

In 1890 $100,000 was appropriated for continuing the improvement of Bayou Plaquemine, of which sum $60,000 was allotted for completing the bank protection on the Mississippi River and $40,000 was allotted to this office.

Under this last allotment a project for the commencement of work upon a lock to connect the Mississippi River with the bayou was presented, and a Board of Engineer Officers was appointed to consider the subject.

Under the direction of this Board plans for a lock of sufficient size to pass four coal boats, or the largest steamers which would be liable to make use of that one lockage, were prepared.

In 1892 $150,000 was appropriated, with a proviso that "of which sum not exceeding $10,000 may be used, in the discretion of the Secretary of War, in removing obstructions from Grand River and Pigeon bayous, forming part of the Bayou Plaquemine route." For securing the bank protection at Plaquemine, $72,000 was allotted from this appropriation.

As the amount available for the construction of the lock was not sufficient to warrant the commencement of the work, it has been held subject to an increase. The estimated cost of lock and approaches is $700.000.

During the fiscal year 1893 titles to all the land expropriated by the United States for a lock have been obtained. The cost of this land, including court charges, etc., amounted to $34,993.23. The buildings located on this property were sold at public auction, and the proceeds of sale, amounting to $2,070.05, were deposited to the credit of the Treasurer of the United States.

Under the appropriation of August 17, 1894, the approved project contemplates the construction of a cofferdam to surround the site, and excavating and piling foundation of the lock. The amount available for this work is $114,200.

Plans and specifications were prepared, proposals invited, and opened June 6, 1895; other preliminary work is now in progress.

Since the bayou is not navigable by vessels engaged in the transportation of merchandise, owing to the communication with the Mississippi River being cut off, the commercial statistics give no indication of the importance of this water route when communication with the Mississippi River shall have been established.

Some idea of the importance of this line of communication can be gleaned from the following table of the value of the commerce carried upon the various streams to which access will be afforded by the completion of the Plaquemine Lock. The figures are compiled from the Report of the Chief of Engineers, and are for the year ending May 31, 1891:

Red River	$6,877,000
Ouachita and tributaries	6,680,600
Courtableau and Des Glaises	3,917,344
Bayou Plaquemine	206,700
Bayou Teche	1,715,026
Bayou Vermilion	1,500,000
Total	20,896,670

It is respectfully urged that sufficient funds be furnished to complete the lock without delay.

SECURING MOUTH OF BAYOU PLAQUEMINE FROM FURTHER CAVING.

This work, transferred to the officer in charge of the fourth district of the Mississippi River in May, 1889, was again placed in charge of this office September 28, 1894, after having been completed.

Under the act of 1888, $75,000 was allotted from the appropriation for improving Bayou Plaquemine, for bank protection to secure the site of the lock proposed to be built at Plaquemine.

The original plan under which the work had been prosecuted contemplated the construction of a series of spur dikes normal to the bank line, placed at intervals of 700 to 1,200 feet along the caving bank. These dikes are about 400 feet long and 150 feet wide, and are built of brush and stone on a similar plan to that formerly employed for the works of bank protection in New Orleans Harbor.

Five of these dikes were completed, 3 above the entrance to the proposed locks and 2 below.

Caving between the dikes having continued, preparations were made to make certain repairs to the work during the low-water season of 1893, but this caving developed to such an extent that it became evident that effective repairs could not be made with the funds available. As in the case of a portion of the New Orleans Harbor work, it became evident that detached spur dikes alone were not effective as a bank protection in this locality, and a project was therefore submitted for constructing continuous revetment between the dikes, with an estimate for $72,000 in addition to the balance on hand.

This project was approved and the amount asked allotted. Under this project continuous revetment has been laid, which, with the spur dikes, forms a continuous protection 1,400 feet long below the site of the lock and 1,200 feet above, with an interval of 500 feet opposite the lock site, which is left for excavating the necessary channel to the lock. The revetment has an average width of about 400 feet.

The work is effective and remains in good condition, requiring but little repair during the past year.

The sum of $20,000 was allotted for repairs to the protecting works from the appropriation of August 17, 1894, for improving Bayou Plaquemine.

Since the partial dredging of Bayou Plaquemine in 1893, which was previously closed to all but sawmill uses and for the smallest vessels, it is being navigated by large-sized steamboats, the number of them increasing each year. Regular and certain communication is now had with the Bayou Teche during the sugar-grinding season, steamboats with barges bringing sugar from there to Indian Village, on Bayou Plaquemine, to be reshipped by rail, and at a much lower rate of freight, it is claimed, than existed before the dredging was done. Shippers and carriers say that business will steadily increase as work on the projected lock progresses, and with the completion of which nearly all of the crops and supplies for five of the richest and largest producing parishes bordering on these waterways will go by this route and at a saving in cost of transportation and time that will much more than repay the costs of its reopening.

The total amount expended on the improvement of Bayou Plaquemine to June 30, 1895, is $309,702.73.

Abstract of appropriations for improving Bayou Plaquemine, Louisiana.

By act of Congress—	
Of August 11, 1888	$100,000
Approved September 19, 1890	100,000
Approved July 13, 1892	150,000
Of August 17, 1894	110,000
Total	460,000

Money statement.

July 1, 1894, balance unexpended	$59,915.02
Amount appropriated by act of August 17, 1894	110,000.00
	169,915.02
June 30, 1895, amount expended during fiscal year	19,617.75
July 1, 1895, balance unexpended	150,297.27
July 1, 1895, outstanding liabilities	165.32
July 1, 1895, balance available	150,131.95
Amount (estimated) required for completion of existing project	1,248,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867, and of sundry civil act of March 3, 1893.

Abstract of proposals for constructing cofferdam and excavating and piling foundation for lock at Plaquemine, La., opened at New Orleans, La., June 6, 1895, by Maj. James B. Quinn, Corps of Engineers.

Name and address of bidder.	For excavating for cofferdam and foundation for lock.	For building and bracing cofferdam.	For furnishing and driving foundation piles.	Total.
Chicago Dredging and Dock Co., Chicago, Ill	$24,400.00	$27,200.00	$65,621.00	$117,421.00
Ethan A. Burris, New Orleans, La	20,500.00	29,000.00	43,750.00	93,250.00
Frederick Harris, Dallas, Tex	41,329.80	20,416.00	51,497.55	113,243.35
W. J. Bentley & Co., New Orleans, La	25,716.00	24,900.00	54,000.00	104,616.00
R. L. Van Sant and R. P. Lutes, St. Louis, Mo.	34,960.00	22,000.00	49,500.00	106,460.00
Charles Clarke & Co., Galveston, Tex	40,000.00	20,500.00	43,500.00	104,000.00
George M. D. Grigsby, Jefferson, Tex	36,000.00	21,000.00	55,900.00	112,900.00

Recommendation was made to the Chief of Engineers that the lowest bid, that of Mr. Ethan Allen Burris, of New Orleans, La., be accepted.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	12
Net tonnage, registered	503
Trips made	277
Gross tonnage, 277 trips	139,331
Barges	8
Net tonnage	2,086
Trips made	201
Gross tonnage, 201 trips	419,286
Total vessels	20
Total net tonnage	2,589
Total trips	478
Total gross tonnage, 478 trips	558,617

Draft of heaviest steamer, light, 3 feet; loaded, 4 feet. Draft of largest barge, light, 15 inches; loaded, 8 feet.

Shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Sugar and molasses	1,341	$108,310	7,119	$631,520
Moss	3	150	7	268
Miscellaneous	3,383	84,575	5,781	181,019
Cotton and cotton seed	10	1,400	53	1,448
Lumber, shingles, etc	129,015	361,242	107,582	295,875
Total	133,752	555,677	120,542	1,110,130
Increase over previous year				554,453

Comparative statement of shipments for four years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1892	131,875	$1,343,608	1894	133,752	$555,677
1893	78,756	1,174,750	1895	120,542	1,110,130

R 7.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

During the high water in the Atchafalaya River a bar forms at the mouth of the Courtableau, but upon the subsidence of the Atchafalaya the reflex water of the bayou causes some scour to take place on the bar.

Acting upon the supposition that if all the water carried by the Courtableau was concentrated upon the bar obstructing its mouth it would be removed, a project was approved in 1879 which had for its object the closing of all bayous flowing out of the Courtableau to the southward to prevent any escape of water by these latter streams, and to construct locks and dams so as to make slack-water navigation, first, to Port Barre, 17 miles upstream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the annual report of 1886 that the cost of masonry, lock, and dam would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar.

The result was favorable, and 3 feet increased depth of water was obtained in two days.

It was reported that the swampers cut one of these dams afterwards, and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise caused one of these dams to break, but it was repaired, and during the following summer good results were hoped for from the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

From the report of Lieutenant Crosby (Annual Report Chief of Engineers for 1887, p. 1376), who made an examination of this stream in September, 1886, it will be seen that the prospects of success, even

with all the run-out bayous closed, are anything but certain, yet the closing of two of the principal outlets in one season did produce an increase of 3 feet depth of water. In view of this fact, and that the project called for the closing of these bayous, work was resumed in October, 1886, with the money appropriated in August of that year.

Slight repairs were made to the old dams in the Big and Little Fordoche, and a new dam was built in Bayou English. Bayou Mamzelle was similarly closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased in December the bar was cutting out rapidly, there being then a channel from 3 to 5 feet deep, while when work began there was one of but a few inches in depth. The new channel was then of no use, however, as the closure of Old River permitted no boats to enter the Atchafalaya from the Mississippi River.

The high water of 1888 formed the bar again as usual, depositing sand to a depth of probably 6 or 8 feet over a length of 2 miles.

From a personal examination made in October, 1888, by Captain Fisk, during low water, it was observed that the preceding high water had cut around one end of each of the dams already built, but they had caused a sand bar to form at each, varying in height from 2 to 3 or 4 feet above the water in the Courtableau at the time of the examination, thus forcing all the water in the bayou to pass out into the Atchafalaya across Little Devil Bar, the head of which was then some 300 or 400 yards above the Little Fordoche. The volume of water, considerably greater than usual at low water, due to heavy local rains, was running with great velocity, and was moving a large quantity of sand, as could be plainly seen, but the depth at the shoalest point could not have been greater than 18 inches.

Had the bar been cut out to a suitable depth for navigation it is doubtful if it would have left sufficient water in the bayou above for purposes of navigation.

As soon as possible preparations were begun after high water in 1888 to repair the existing dams and to build others, and for closing some of the remaining outlets, but before the plant which was to be used on the work could be put in repair the water rose to such a height that nothing could be done.

The water having fallen sufficiently, work was resumed on September 2, 1889. The broken dams in bayous Mamzelle, English, and Fordoche were all repaired and left in good condition. Bayous Big Cane and Little Cane, both of which are small and of little importance, were obstructed by slashing trees into them, and the boats taken to Bayou Juramon on November 23 for work; but the water rose so rapidly the plant and lumber had to be taken to Washington, laid up, and the crew discharged November 30, 1889.

Nothing was done during the fall of 1890 beyond slight repairs to the derrick boat, and, owing to high water, work was not resumed until September of the following year.

The dams at bayous Cane, Mamzelle, and Big Fordoche were all repaired with piles and sheet piles, brush aprons placed above and below them, held down by sinking trees and earth, and left in good condition. The work was discontinued November 20, and the plant laid up at Washington, La.

It is doubtful if the completion of the present project will permanently remove the bar at the mouth, as Little Devil Bar will reform at each high water of the Atchafalaya River.

All of the dams are now in bad condition.

August 17, 1894, Congress appropriated $5,000 for continuing the improvement. The approved project under this appropriation is to repair the dams across bayous Fordoche, Mamzelle, Big and Little Cane, and, if funds will permit, to close the small bayous between bayous Mamzelle and Big Cane.

Bids were invited for a suitable plant for this work, the same having been opened June 27, 1895.

Little Devil Bar at the entrance to the Bayou Courtableau is still an obstruction to its navigation. Frequently it is so late before steamboats can pass over this bar that the crops and supplies have to be moved by other and more expensive means of transportation.

To June 30, 1895, there had been expended on the improvement of Bayou Courtableau the sum of $31,058.98.

For continuing the improvement, by constructing dams and repairs to those already built, the sum of $5,000 can be economically expended during the ensuing year.

Abstract of appropriations for improving Bayou Courtableau, Louisiana.

By act of Congress approved—	
June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
August 5, 1886	5,000
By act of Congress—	
Of August 11, 1888	5,000
Approved September 19, 1890	2,200
Of August 17, 1894	5,000
Total	36,200

Money statement.

July 1, 1894, balance unexpended	$163.52
Amount appropriated by act of August 17, 1894	5,000.00
	5,163.52
June 30, 1895, amount expended during fiscal year	22.50
July 1, 1895, balance unexpended	5,141.02
July 1, 1895, outstanding liabilities	20.50
July 1, 1895, balance available	5,120.52
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	5,000.00

Abstract of proposals received for hire of a steamboat for improving Bayou Courtableau, Louisiana, opened at New Orleans, La., June 27, 1895, by Maj. James B. Quinn, Corps of Engineers.

Name and address of bidder.	Price per day.
Frank Ottendorfer, New Orleans, La	$45.50

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	1
Net tonnage, registered	242
Trips made	27
Gross tonnage, 27 trips	6,524

Draft of steamer, light, 2 feet; loaded, 5 feet.

No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar and molasses	1,728	$162,056	473	$20,523
Rice	1,014	31,244	298	10,659
Cotton and cotton seed	3,685	126,137	1,604	87,928
Miscellaneous	68	4,374	100	7,177
Total	6,495	323,811	2,475	126,287
RECEIPTS.				
Merchandise	2,700	162,000	1,620	40,500
Grand total	9,195	485,811	4,095	166,787

Comparative statement of receipts and shipments for six years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1890	35,867	$4,629,584	1893	14,848	$677,529
1891	32,618	3,917,344	1894	9,195	485,811
1892	20,041	994,471	1895	4,095	166,787

R 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

Ordinarily this bayou is navigable for steamboats throughout the year.

Prior to 1886 logs, snags, and impending trees obstructed the channel, but money having been appropriated the stream was thoroughly cleared of such obstructions from Port Barre down.

In 1890 Congress appropriated $5,000 with which to remove the obstructions that had found their way into the bayou since 1886.

Operations were commenced at St. Martinsville in October, 1891, with hired plant, and the improvement extended to a point about 59 miles below. Work was discontinued December 10, 1891. The main obstructions removed from the channel as the result of the year's work were 238 snags, 144 piles, 98 overhanging limbs, 36 overhanging trees, 30 fallen trees, 50 sunken logs, 18 floating logs, and 37 stumps.

Since the improvement in 1891 shoals had formed by material washed into the stream from large drainage ditches, on which, during the prevalence of northers in the low-water season, the available depth was not more than 3 feet.

Under the appropriation of $6,000, made August 17, 1894, for continuing improvement, these shoals were dredged out under contract. The work was commenced February 4, 1895, at Loreauville, and carried on to a point 2 miles below Franklin, a distance of about 70 miles, where operations were discontinued on May 7, 1895, exhausting the funds.

Besides the dredging of some 98,250 cubic yards of material from the bars, there were removed from the channel 215 sunken logs, 6 snags, 38 stumps, 3 wrecks, and 39 overhanging trees.

The channels through these bars were dredged to a depth of 8 feet at low water, with a width of fully 50 feet.

The improvement of the Teche can not be considered as permanent, as sunken logs, fallen trees, and wrecks of coal boats are continually forming obstructions which will require removal.

To the close of the year ending June 30, 1895, there has been expended on the improvement of this stream the sum of $60,934.38.

The steamboat men and the lumber men have expressed satisfaction with the dredging work recently done in the bayou, and declare its navigable condition for all purposes much improved, better in fact than it has been for many years. They appreciate the effect of the dredging, particularly from the fact that the bayou had become seriously obstructed in many places because of the drainage and refuse from the large sugar-cane fields, sugar mills, refineries, sawmills, etc., passed into the bayou. Much of the trouble caused thereby has been removed, but they desire further dredging, particularly in the vicinity of New Iberia and above to Breaux Bridge.

The transportation and shipping interests greatly desire the opening of the route through Bayou Plaquemine by locks into the Mississippi River. The better facilities for shipping and the amount which will be saved in the cost of transportation by the completion of this work, it is claimed, will be of almost incalculable benefit.

There are three ways of shipping, viz: By steamboat and the Southern Pacific Railroad, and by steamboat, all water, through Larompe River, Grand Lake, the Atchafalaya and Mississippi rivers, to New Orleans. The competition afforded by the latter means, quickened as it has been by the partial dredging of the Bayou Plaquemine route, and immediately taken advantage of by steamboats, has caused a reduction in freight rates on sugar in barrels, alone, from 60 to 30 cents.

It is believed that $24,000 can be most advantageously expended during the ensuing year for the improvement of Bayou Teche.

Abstract of appropriations for improving Bayou Teche, Louisiana.

By act of Congress approved—	
July 11, 1870	$17,500
June 14, 1880	6,000
March 3, 1881	20,000
July 5, 1884	6,500
September 19, 1890	5,000
By act of Congress of August 17, 1894	6,000
Total	61,000

Money statement.

July 1, 1894, balance unexpended	$564.99
Amount appropriated by act of August 17, 1894	6,000.00
	6,564.99
June 30, 1895, amount expended during fiscal year	6,499.37
July 1, 1895, balance unexpended	65.62
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	24,000.00

Abstract of proposals received for furnishing a dredge for improving Bayou Teche, Louisiana, opened at New Orleans, La., January 10, 1895, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Prices per day for hire of dredge.
1	L. J. Dodge and Wm. J. Bentley, New Orleans, La	$100
2	De Witt Dilworth, New Orleans, La	110
3	Henry Camors, New Orleans, La	79

Contract awarded to Henry Camors, with the approval of the Chief of Engineers. Contract dated January 17, 1895, and approved January 23, 1894. Work to be commenced within sixty days after approval of contract and completed on or before June 1, 1895.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	33
Net tonnage, registered	2,521
Trips made	1,458
Gross tonnage, 1,458 trips	3,675,618
Barges	39
Net tonnage	3,675
Trips made	514
Gross tonnage, 514 trips	1,888,950
Total vessels	72
Total net tonnage	6,196
Total trips	1,972
Total gross tonnage	5,564,568

Draft of heaviest vessel, light, 2 feet; loaded, 8 feet.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar	47,305	$4,841,144	59,402	$4,230,885
Molasses	9,303	210,802	6,062	109,450
Rice	1,536	47,355	559	17,534
Potatoes and onions	21	593	14	315
Eggs	16	2,312	30	4,594
Moss	51	2,056	34	1,354
Pecans	22	360	5	690
Hides	12	784	8	1,066
Cotton and cotton seed	4,076	230,157	1,843	18,610
Cotton-seed oil	146	11,869	210	840
Wood	375	4,375	12,985	18,620
Miscellaneous	29,537	159,915	30,753	209,157
Total	92,400	5,511,722	102,905	4,613,115
RECEIPTS.				
Machinery, merchandise, coal, saw logs, etc	290,754	1,867,067	177,023	1,181,368
Grand total	383,154	7,378,789	279,928	5,794,483

Comparative statement for five years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1891	26,905	$1,715,026	1894	383,154	$7,378,789
1892	64,866	833,110	1895	279,928	5,794,483
1893	115,080	5,754,542			

The supply of Pittsburg coal consumed in sugar making, etc., is not included in above statistics. For the year ending May 31, 1894, the receipts of coal amounted to 134,065 tons, valued at $507,892. On account of shoals in Grand Lake and Larompe River, through which the coal must pass from the Mississippi River to the bayou, no coal was received up to the 31st of May, 1895.

R 9.

IMPROVEMENT OF CHANNEL, BAY, AND PASSES OF BAYOU VERMILION, LOUISIANA.

In 1891 a preliminary examination was made of the bayou, bay, and passes.

A project was approved in 1892 which provided for the removal of snags, overhanging trees, and logs in the bayou, and the driving of guide piles in the bay for marking the channels, at an estimated cost of $25,000.

An appropriation of $7,500 was made for this work July 13, 1892.

Bids were invited by advertisement for furnishing a suitably equipped steamboat for the work in the bayou and bay. The proposals submitted were opened October 7, 1892, and the award of contract made to Victor Von Schoeler, of Franklin, La., for the best and most suitable boat of those offered.

The plant contracted for consisted of a stern-wheel steamboat, with a crew of fourteen men, supplied with a steam capstan, steam winch, derrick, blocks and tackle, and one electric battery for removing obstructions, and one pile driver for driving guide piles in Vermilion Bay.

The contractor commenced snagging operations about 18 miles above the mouth of the bayou on December 1, 1892.

The work was carried on up the bayou, and resulted in the improvement of 37½ miles of channel by the removal of 3,032 obstructions.

The contractor completed the snagging work on March 9, 1893, but owing to the loss of his boat he was unable to complete the driving of the 50 guide piles in the bay by the date of the expiration of the contract, and an extension of time to July 31, 1893, was granted. This work was finished on July 25, 1893.

The act of August 17, 1894, appropriated $5,000 for continuing the improvement, under which the approved project contemplates the clearing of the stream above Abbeville for a distance of about 30 miles, or so much thereof as may be possible with the funds available.

Accordingly contract was entered into April 25, and approved May 3, 1895, for the hire of a steamboat suitably equipped for the work.

The contractor commenced operations June 3, 1895, and up to the end of that month had removed 53 snags, 60 sunken logs, 13 stumps, and 363 overhanging trees.

The total amount expended on this improvement to June 30, 1895, was $7,081.07.

This year a steamboat has been making regular trips from the Bayou Vermilion through to New Orleans, via Larompe, Grand Lake, Atchafalaya and Mississippi rivers. This is the first time a steamer has been so employed in many years, and although the route is a long and circuitous one, it is asserted that freight is now being carried cheaper than by the former part-water and part-rail route.

It is confidently claimed that with the opening of the Bayou Plaquemine route by means of locks connecting with the Mississippi River, the time and cost of transportation will be so much lessened that nearly all of the shipments will go by the all-water route.

Abstract of appropriations for improving the channel, bay, and passes of Bayou Vermilion, Louisiana.

By act of Congress—	
Approved July 13, 1892	$7,500
Passed August 17, 1894	5,000
Total	12,500

Money statement.

July 1, 1894, balance unexpended		$445.81
Amount appropriated by act of August 17, 1894		5,000.00
		5,445.81
June 30, 1895, amount expended during fiscal year		26.88
July 1, 1895, balance unexpended		5,418.93
July 1, 1895, outstanding liabilities	$1,675.33	
July 1, 1895, amount covered by uncompleted contracts	3,240.00	
		4,915.33
July 1, 1895, balance available		503.60
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals received for furnishing a snag boat, etc., for improving the channel, bay, and passes of Bayou Vermilion, Louisiana, opened at New Orleans, La., March 82, 1895, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Prices per day for hire of snag boat.
1	Usner & Dawson New Orleans, La	$70
2	Henry Camors, New Orleans, La	87
3	Eli Wise, Abbeville, La	65

Contract awarded to Eli Wise, of Abbeville, La., with the approval of the Chief of Engineers, he being the lowest bidder for the best and most suitable plant. Contract dated April 25, 1895, and approved May 3, 1895; work to be commenced within thirty days after approval of contract, and completed on or before August 31, 1895.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	5
Net tonnage, registered	345
Trips made	367
Gross tonnage, 367 trips	126,315
Schooners	5
Net tonnage, registered	68
Trips made	113
Gross tonnage, 113 trips	7,685
Barges	4
Net tonnage	406
Trips made	225
Gross tonnage, 225 trips	91,350
Total vessels	14
Total net tonnage	819
Total trips	705
Total gross tonnage	225,350

Draft of heaviest vessel, light, 3 feet; loaded, 8 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Lumber	26,500	$33,000	3,582	$20,520
Rice	1,341	39,900	2,273	71,271
Cotton	884	122,870	834	96,660
Cotton seed	1,372	24,054	1,338	13,380
Wood			1,239	1,768
Cattle	1,135	25,900	192	8,290
Sugar	2,611	284,852	1,421	146,325
Molasses	201	6,900	56	1,014
Merchandise	7,281	374,151	2,058	69,944
Coal	2,497	12,150		
Total	43,822	923,777	12,993	429,172

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1893	35,671	$1,227,365
1894	43,822	923,777
1895	12,993	429,172

The Pittsburg coal annually consumed for sugar-making purposes had not been received when this report was closed, on account of detention at the shoal places en route in Grand Lake and Larompe River.

R 10.

IMPROVEMENT OF MERMENTAU RIVER AND TRIBUTARIES, LOUISIANA.

In 1891 a survey of this river was made, including its tributaries and course through Lake Arthur and Grand Lake to the Gulf of Mexico, Louisiana.

The project adopted in 1892 was estimated to cost $23,615.25, and provided for the removal of snags, logs, and overhanging trees in the upper river and a mud flat in the lower.

July 13, 1892, Congress appropriated $7,500 for this improvement.

Bids were invited by advertisement for furnishing a suitable steamboat for snagging purposes. The bids submitted were opened October 6, 1892, and the award of contract was made to Harvey & Erlinger, of Harveys Canal, Louisiana, they having the best and most suitable boat of those offered.

The plant contracted for consisted of a stern-wheel steamboat with a crew of 15 men, supplied with a steam capstan, steam winch, and two derricks for removing obstructions, one electric battery for blasting stumps, and all other necessary appliances for this class of work.

Work under this contract was commenced December 8, 1892, at the lower end of Lake Arthur and proceeded on up the Mermentau River, improving that part of the channel most used for a distance of 38 miles by removing 556 obstructions, consisting of 383 snags, 172 overhanging trees, and 1 wreck. The contract was completed March 7, 1893.

August 17, 1894, Congress appropriated $5,000 for continuing the improvement. Under this appropriation a project was submitted January 17, 1895.

The work already done is in good condition. At present the desire is to deepen the water at the Gulf entrance to the river, and also to increase the depths of the channels through Mud Lake, but with the funds available it is not deemed prudent to undertake this work, since nothing of a substantial or satisfactory character could be secured.

The sum of $11,115.25 can be advantageously expended on this improvement during the next year.

The total amount expended on these streams to June 30, 1895, was $7,115.44.

Abstract of appropriations for improving Mermentau River and tributaries, Louisiana.

By act of Congress—	
Approved July 13, 1892	$7,500
Passed August 17, 1894	5,000
Total	12,500

Money statement.

July 1, 1894, balance unexpended	$423.89
Amount appropriated by act of August 17, 1894	5,000.00
	5,423.89
June 30, 1895, amount expended during fiscal year	39.33
July 1, 1895, balance unexpended	5,384.56
Amount (estimated) required for completion of existing project	11,115.25
Amount that can be profitably expended in fiscal year ending June 30, 1897	11,115.25
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	9
Net tonnage, registered	291
Trips made	475
Gross tonnage, 475 trips	138,225
Schooners	6
Net tonnage, registered	149
Trips made	46
Gross tonnage, 46 trips	6,854

Barges	13
Net tonnage	715
Trips made	374
Gross tonnage, 374 trips	267,410
Total vessels	28
Total net tonnage	1,555
Total trips	895
Total gross tonnage	412,489

Draft of heaviest vessel, light, 3 feet; loaded, 5 feet 7 inches.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Rice	4,265	$150,000	6,637	$208,107
Lumber	240	1,875	5,123	17,496
Wood	300	1,875	2,047	2,945
Merchandise	632	35,200	2,148	71,615
Total	5,437	188,950	15,955	300,163
Increase over previous years			10,518	111,213

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1893	16,250	$324,900
1894	5,437	188,950
1895	15,955	300,163

R 11.

IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

In 1874, and again 1882–83, cuts were made through the bars in Calcasieu Lake above Calcasieu Pass. The dredged channel was 8 feet deep, 70 feet wide, and 7,500 feet long. The work was done under contract.

The channel had again shoaled in 1885 to a depth of 3½ feet and needed redredging, but by an unfortunate wording of the appropriation, funds in hand for "improving Calcasieu River" could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and river.

Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 130 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet wide and 6 feet deep, the material excavated to be thrown outside the revetment walls.

The same contract also provided for the excavation of a channel through the bar at the mouth of Calcasieu River, at the northern end of the lake, 100 feet wide and 6 feet deep. Work was commenced on the revetments in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness due to exposure on this work.

In the spring of 1887 work was resumed by the administrator of the contractor's estate, and the revetment nearly completed. At the date of the annual report for 1887 a dredge was expected to begin work within a few weeks, and actually arrived there about the middle of August, but was not ready for work until the last of November on account of repairs necessary and the delay in making them.

About the middle of September, when it was thought the dredge would be ready for work in a few days at the very latest, the administrator began driving down the planking of the revetment into the ditch the water had dug under it, but after one day's work stopped. No work was done by him after that time, and the contract was annulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do this work by hired labor and open-market purchase, using the Government dredge which had shortly before finished the improvement of Bayou Terrebonne. A careful examination developed the fact that the revetment was so badly worm-eaten as to be worthless, showing that the life of timber there was short. Application was made to so far modify the project as to omit the revetment, and this modification was approved by the Chief of Engineers January 12, 1888. The dredge was put in good condition and began work on the 19th of March.

Two deck barges were hired and arranged for use as dump scows, but two days' work with them showed that the wooden shafts or Spanish windlasses, used for closing the dumping doors, were not strong enough. These were replaced with 3-inch iron shafting and worked well. The material taken out by the dredge amounted to 77,159 cubic yards, completing the work as projected August 31, 1888.

In 1888 $10,000 was appropriated for continuing this work, but as the former work did not prove to be permanent and the amount was too small to begin operations with, it was held subject to future consideration.

In 1890 Congress appropriated $75,000 for "improving the mouth and passes of Calcasieu River," according to the plan reported by Maj. W. H. Heuer, Corps of Engineers, in 1886, and confirmed by Capt. W. L. Fisk, Corps of Engineers, in his report of November, 1888.

As this project was for the improvement of the mouth of the Calcasieu River by means of jetties, etc., which must be built in a very much exposed location in the Gulf, the amount of money available was considered to be entirely too small with which to commence operations economically, and was accordingly held for future increase.

The act approved July 13, 1892, appropriated $100,000 for the improvement of the passes and river, and accordingly a contract was let for the construction of a jetty upon the east side of the channel across the bar at the mouth of the pass, and a contract for 10,000 linear feet of revetment for the northern side of a channel to be dredged through the bar at the head of the pass. For the dredging, although advertised, no bid was received sufficiently low to warrant acceptance, and accordingly authority was obtained for digging this channel with the Government dredge.

The 10,000 linear feet of revetment was completed August 6, 1893, the contractor using in its construction 3,345 piles and 44 barge loads of slabs. In November, 1893, the revetment was considerably damaged by storm, and $3,102.80 was expended in its repair. A subsequent storm resulted in some damage, but no funds are available with which to further repair the structure.

The dredging was commenced in July, 1893, and considerable progress was made until February, 1894, when the dredge, having become unserviceable through decay, was hauled out and put in thorough repair.

The material was very soft and flattened out without making a bank, as was expected. In consequence the revetment did not receive the protection from this source that was expected, and was accordingly nearly swept away by severe storms. A substantial structure for the breakwater could not be built for the allotted amount of money that would withstand the effect of storms without the protection of the earth covering, and as this proved to be too soft to be of any use the wreck was inevitable and the result very disappointing.

Dredging was resumed August 3, 1894, and continued until November 1 following, completing the projected channel at the foot of Calcasieu Lake.

A greater depth was given to the cut and material of greater consistency secured. The channel has remained in use without refilling and has given considerable relief.

The contractors continued work on the east jetty, but owing to unfavorable weather retarding operations they were granted an extension of time, finally completing the same August 11, 1894.

This jetty is similar to those at Sabine Pass, viz, a foundation mat of brush, and upon this a riprap structure to reach 2 feet above mean high water.

There has been used in the construction of the east jetty at the time of the completion of the contract August 11, 1894, 33,054.23 tons of riprap stone and 22,396.67 square yards of brush mattress. Its total length is 7,347 feet.

Under the appropriation of $90,000 made August 17, 1894, the approved project contemplates dredging channels through the bar at the head of Calcasieu Lake, the capping of 7,000 feet of the east jetty, or such part thereof as funds available will permit, with stone, and with the unexpended balance, if any, dredging a channel 12 feet deep and as wide as funds permit from the 12-foot contour inside to the 12-foot contour outside.

Upon the completion of the channel at the foot of Calcasieu Lake the dredge was towed to the bar at the head of the lake, where work was commenced on November 5, 1894. The dredge discontinued work at this place on June 30, 1895, and preparations were made for its removal to the mouth of the Sabine River, Texas, for work there.

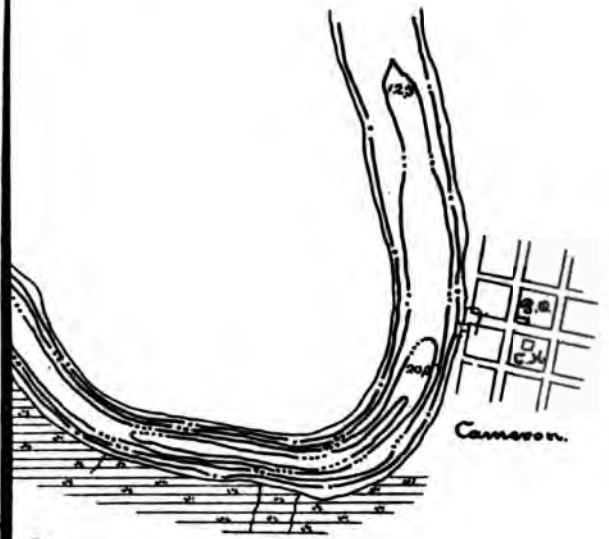
The total amount of material dredged during the past year was 196,509 cubic yards.

It is thought that the money to be expended in dredging will give a channel 60 feet wide and 8 feet deep from deep water in the river to deep water in the lake, although it is not believed that the channel can be preserved any great length of time without properly revetting it so as to prevent the washing in of the dredged material.

For the capping of the east jetty with stone contract was let November 20, approved November 30, 1894, and work under the same commenced January 28, 1895.

To the end of the fiscal year the contractor had completed 5,652 linear feet of capping, using 8,045.77 tons of stone.

Under the protection afforded by the jetty so far completed the current of the river has been able to scour out a tolerably straight channal across the bar, which, at the time of the survey, had a depth of over 7 feet, but reports received since then indicate that the channel depth exceeds this somewhat.



Improving
River Pass, La.
Pleasier Pass.

pril 1 st. to May 8th. 1895

er the direction of

inn, Corps of Engineers, U.S. Army

by

unles, Asst. Engineer.

Scale of feet
2000' 4000' 6000'

The total amount expended on the improvement to June 30, 1895, was $260,287.86.

Abstract of appropriations for improving mouth and passes of Calcasieu River, Louisiana.

By act of Congress—	
Approved June 10, 1872	$15,000
Approved March 3, 1881	15,000
Passed August 2, 1882	10,000
Approved July 5, 1884	6,500
Of August 11, 1888	10,000
Approved September 19, 1890	75,000
Approved July 13, 1892	100,000
Passed August 17, 1894	90,000
Total	321,500

Money statement.

July 1, 1894, balance unexpended		$56,955.54
Amount appropriated by act of August 17, 1894		90,000.00
		146,955.54
June 30, 1895, amount expended during fiscal year		85.743.40
July 1, 1895, balance unexpended		61,212.14
July 1, 1895, outstanding liabilities	$17,019.45	
July 1, 1895, amount covered by uncompleted contracts	18,149.91	
		35,169.36
July 1, 1895, balance available		26,042.78
Amount (estimated) required for completion of existing project		335,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		335,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals received for capping jetty with stone for improving mouth and passes of Calcasieu River, Louisiana, opened at New Orleans, La., October 25, 1894, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Granite capping blocks, prices per ton of 2,240 pounds.	Total (on estimate of 12,000 tons).
1	F. A. Hyatt, Beaumont, Tex.	$5.40	$64,800
2	Charles Clarke & Co., Galveston, Tex.*	4.59	55,080

* Lowest bid.

Contract awarded to Charles Clarke & Co., of Galveston, Tex., with the approval of the Chief of Engineers, at $4.59 per ton of 2,240 pounds, on an estimate of 12,000 tons. Contract dated November 20, 1894, and approved November 30, 1894; work to be commenced within sixty days after approval of contract, and completed on or before December 31, 1895.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	11
Net tonnage, registered	390
Trips made	634
Gross tonnage, 634 trips	247,260

Schooners	16
Net tonnage, registered	480
Trips made	314
Gross tonnage, 314 trips	9,500
Barges	21
Net tonnage	3,416
Trips made	238
Gross tonnage, 238 trips	812,908
Total vessels	48
Total net tonnage	4,286
Total trips	1,186
Total gross tonnage	1,069,668

Draft of heaviest vessel, light, 6 feet; loaded, 9 feet.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Lumber	289,253	$1,030,819	221,946	$562,061
Shingles	39,375	78,750	14,000	19,250
Cotton	571	79,625	629	27,000
Rice	832	26,550	521	16,342
Merchandise	14,942	384,830	17,298	163,601
Total	344,973	1,600,574	254,394	788,274

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1893	207,545	$2,141,750
1894	344,973	1,600,574
1895	254,394	788,274

R 12.

IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

The original depth of water on the bar obstructing the entrance to Sabine Pass, Tex., did not exceed 6 feet. Attempts were made in 1878 and 1880 to increase this to 12 or 16 feet by dredging, but the dredged channels, being unprotected, soon filled up. In 1882 a project was approved for improving this entrance by means of jetties and dredging, at an estimated cost of $3,177,606.50.

Since the approval of this project there has been appropriated $1,723,750. A total of $1,716,091.96 had been expended to June 30, 1894, of which sum $1,396,091.96 was expended upon the present approved project.

At the start the jetties were built of layers of brush and rock ballast, but it was found that the brush which was placed in the jetties above the bottom course almost entirely disappeared, and at present a large brush mattress is sunk for a foundation, and the rock jetty is built upon this until the crest is about 2 feet above mean high water.

As far as observations extend it appears that the mats suffer some compression, and there is an apparent settlement of the jetties since the last survey of about 0.5 of a foot. There has been no settlement in either the rock section or the concrete survey station. There is also

some loss of the height of the jetty caused by the action of the waves, and it will require some money for the preservation of the jetties during the time of construction as well as after completion.

August 17, 1894, Congress appropriated $275,000 for continuing the improvement of Sabine Pass, and, by a subsequent act, a sum not exceeding $4,000 was set aside from this amount for dredging and deepening the channel of the Sabine River across the bar at the mouth of the river in Sabine Lake.

The approved projects under this appropriation contemplate the extension of the east jetty, dredging between the jetties, and dredging across the bar at the mouth of the Sabine River, the latter work to be done with the Government dredge and hired labor after it shall have completed the channel at the head of Calcasieu Lake.

CHANNEL BETWEEN JETTIES.

Dredging was resumed July 1, 1893, and continued until February 23, 1894, removing from the channel 198,401.26 cubic yards of material, completing the contract.

Under the appropriation of August 17, 1894, contract was entered into and approved, covering the sum of $115,000, for dredging. The contractor commenced operations March 27, 1895, and to the end of the fiscal year had removed 155,069 cubic yards of material. The total amount of material removed from the channel since the commencement of dredging in February, 1893, is 514,446.85 cubic yards.

The channel is now 100 feet wide and full 16 feet deep at mean low tide from deep water in the pass to the 17-foot contour of depth in the Gulf, except for a very short distance beyond the ends of the jetties, where there is a deficiency of about 0.2 of a foot, a quantity so small as to detract practically nothing from the continuation of the 16-foot channel throughout.

A very considerable deepening throughout the whole and between the jetties is apparent, and with the exception of the shoal spot above mentioned the dredged channel is improved.

As an evidence of the practicability of the channel the schooner *Senator Sullivan*, drawing 18.9 feet, passed out safely and without delay on June 24, 1895, and it is of common occurrence for vessels to pass through the channel drawing 16 feet and over. No apprehension relative to the maintenance of the dredged channel need be entertained.

JETTIES.

The completion of the contract, June 15, 1894, added 39,150.29 gross tons of riprap stone and 23,333.31 square yards of brush mattress to the west jetty.

This jetty is 14,875 feet long, 6,609 feet of which is raised to 2 feet above mean high water, and 7,966 feet has been brought up to mean low water. The outer 300 feet is foundation work only.

The work of extending the east jetty was commenced by the contractor on March 10, 1895, and has resulted, up to the end of the fiscal year, in the placing of 6,433.99 tons of riprap stone and 13,294.43 square yards of brush mattress.

The completion of the portion of the east jetty now under contract will afford great security to the dredged channel, but it is not deemed to be sufficient to afford complete protection, and should be extended to the limit projected.

The west jetty has not been capped with large blocks, and is in an unfinished state, and it should be completed as designed in order to be safe.

The east jetty had at the close of the fiscal year ending June 30, 1895, a total length of 18,465 feet, 16,615 feet of which was 2 feet above mean high water, the remainder being foundation work only.

The total amount expended on this improvement to June 30, 1895, was $1,779,044.52.

Abstract of appropriations for improving harbor at Sabine Pass, Tex.

From act approved August 30, 1852 (survey)	$5,000
Allotted from act of Congress approved June 10, 1873 (for survey)	2,000
By act of Congress approved—	
March 14, 1875	20,000
August 14, 1876	38,000
June 18, 1878 (allotted)	30,000
March 3, 1879	25,000
June 14, 1880	50,000
March 3, 1881	150,000
By act of Congress passed August 2, 1882	150,000
By act of Congress approved—	
July 5, 1884	200,000
August 5, 1886	198,750
By act of Congress of August 11, 1888	250,000
By act of Congress approved—	
September 19, 1890	300,000
July 13, 1892	350,000
By act of Congress passed August 17, 1894	275,000
Total	2,043,750

Money statement.

July 1, 1894, balance unexpended		$52,658.04
Amount appropriated by act of August 17, 1894		275,000.00
		327,658.04
June 30, 1895, amount expended during fiscal year		62,952.56
July 1, 1895, balance unexpended		264,705.48
July 1, 1895, outstanding liabilities	$29,558.66	
July 1, 1895, amount covered by uncompleted contracts	216,019.25	
		245,577.91
July 1, 1895, balance available		19,127.57

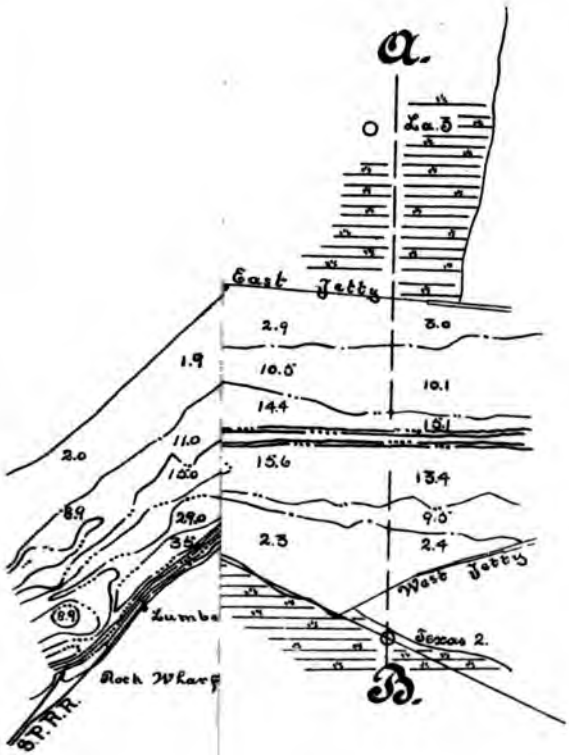
Amount (estimated) required for completion of existing project	1,453,856.50
Amount that can be profitably expended in fiscal year ending June 30, 1897	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Plate 1.

To accompany annual report of June 30th, 1895.

Major, Corps of Engineers, U.S. Army.



Abstract of proposals received for extension of east jetty and for dredging at harbor of Sabine Pass, Tex., opened at New Orleans, La., October 29, 1894, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Jetty extension.					Dredging.	
		22,250 square yards of brush mattress (per square yard).	26,000 tons riprap stone for hearting (per ton of 2,240 pounds).	5,000 tons granite riprap stone (per ton of 2,240 pounds).	4,000 tons granite capping blocks (per ton of 2,240 pounds.	Total.	1,150,000 cubic yards of dredging (per cubic yard).	Total.
							Cents.	
1	Julius Hess, Detroit, Mich						16½	$189,750
2	New York Dredging Co., New York, N. Y						12	138,000
3	Thomas Doyle, Galveston, Tex						12	138,000
4	F. A. Hyatt & Co., Sabine Pass, Tex.*	$0.80	$2.50	$2.85	$4.55	$115,250.00		
5	Charles Clarke & Co., Galveston, Tex	.79	3.15	3.15	3.15	127,827.50	13	149,500
6	Jno A. Davis, Galveston, Tex	1.25	3.20	4.25	4.89	154,162.50		
7	Rittenhouse Moore Dredging Co., Mobile, Ala.†						9	103,500
8	Roderick G. Ross, Jacksonville, Fla	.95	3.45	3.60	4.50	146,837.50		

* Lowest bid for jetty extension. † Lowest bid for dredging.

Contract for jetty extension awarded to F. A. Hyatt & Co., of Sabine Pass, Tex., and contract for dredging awarded to Rittenhouse Moore Dredging Company, Mobile, Ala., with the approval of the Chief of Engineers. The jetty contract dated January 4, 1895, approved January 15, 1895, and to be completed on or before March 31, 1896. The dredging contract dated January 7, 1895, approved January 24, 1895, and to be completed on or before May 31, 1896.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Vessels	64
Trips	378
Tonnage, registered	21,784

Draft of heaviest vessel, light, 11 feet; loaded, 17 feet 4 inches.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber	28,892	$173,352	30,834	$164,081
Merchandise	580	14,750	1,415	20,535
Total	29,472	188,102	32,249	184,616
RECEIPTS.				
Rock	13,774	43,387	5,115	14,355
Coal	2,700	11,800	1,275	5,427
Merchandise	1,020	36,900	9,052	48,425
Grand total	46,966	280,189	47,691	252,828
Increase over previous year			725	

Comparative statement of receipts and shipments for four years.

Year ending May 31—	Tons.	Value.	Year ending May 31—	Tons.	Value.
1892	38,028	$225,963	1894	46,966	$280,189
1893	15,050	180,950	1895	47,691	252,823

R 13.

IMPROVEMENT OF SABINE RIVER, TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872–73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year.

The estimated cost of improvement over this stretch of river by the removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000.

Congress appropriated $10,000 in 1878 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide was dredged over the bar at the mouth.

In 1879 Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton. After the survey was completed it was deemed advisable to spend this money in improving the river above Orange, and cuts were made from the main river into the Narrows and at Dead Bend.

Large numbers of sunken logs and snags were removed from the upper part of the Narrows, enabling vessels of 5 feet draft to get 30 miles above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more, for this river. The bar at the mouth had again shoaled. This was redredged in 1881–82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length. Since then the bar has shoaled and now has an insufficient depth of water.

In 1882 Congress appropriated $4,000 more for this improvement. As the river was in a sufficiently good condition for the limited commerce which it carried, this money was held for further use.

An examination in May, 1889, showed many snags and some shoal places in the part of the channel known as The Narrows, and as some $4,000 was available for work, a project was submitted for removing the snags and closing the two Old River branches with dams of piles, brush, and earth, to throw all the water into The Narrows.

This project was approved, the work advertised, and contract was entered into September 20, 1889, with the Sabine Tram Company to complete the work by December 1, 1889, for $3,647.

The smaller dam was successfully built, and most of the piles driven for the larger one, when a sudden rise in the river washed out many of them. The water continued rising and remained so high that satisfactory work could not be done, so that the contract was extended to October 30, 1890, by the Chief of Engineers. Work was resumed in September, 1890, and finished in December of that year, completing the project.

The approved project of 1892 provides for the improvement of the river between Sabine Lake and Sudduths Bluff by the removal of snags and other obstructions, at a cost of $10,000.

July 13, 1892, an appropriation of $5,000 was made for improving the Sabine River up to Sudduths Bluff, Texas.

Bids were invited for furnishing a steamboat for work under this appropriation. Those received were not deemed advantageous to the Government, and they were rejected with the approval of the Chief of Engineers. The work was readvertised and award of contract made.

The contractor commenced work at a point 18 miles above Orange on July 1, 1893, and completed the same on September 26 following, during which time 1,325 obstructions were removed, improving 17½ miles of channel.

By the act of August 17, 1894, $5,000 was appropriated for the completion of the project.

March 2, 1895, an act was passed diverting the sum of $4,000 from the appropriation for improving Sabine Pass, Tex., for the dredging and deepening of the channel across the bar at the mouth of the Sabine River.

Obstructions having re-formed in the cleared channel above Morgans Bluff, the approved project under this appropriation is to remove these obstructions and also to continue the improvement to Sudduths Bluff. Accordingly, bids were invited and contract awarded for a suitable plant for the work. This contract was approved February 26, 1895, the date fixed for commencement of the work being July 1, 1895.

It is estimated that $2,000 will be required annually to keep the river in condition after the snags are removed.

There has been expended on the improvement of this river to June 30, 1895, the sum of $39,615.44.

The sum of $83.47 was expended during the year just closed.

Abstract of appropriations for improving Sabine River, Texas.

Allotted from act approved June 10, 1872	$2,700
By act of Congress approved—	
June 18, 1878	10,000
March 3, 1879	6,000
June 14, 1880	5,000
March 3, 1881	7,000
By act of Congress—	
Passed August 2, 1882	4,000
Approved July 13, 1892	5,000
Passed August 17, 1894	5,000
Total	44,700

Money statement.

July 1, 1894, balance unexpended	$168.03
Amount appropriated by act of August 17, 1894	5,000.00
	5,168.03
June 30, 1895, amount expended during fiscal year	83.47
July 1, 1895, balance unexpended	5,084.56
July 1, 1895, amount covered by uncompleted contracts	4,500.00
July 1, 1895, balance available	584.56
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,000.00

Abstract of proposals received for furnishing a snag boat for improving Sabine River, Texas, opened at New Orleans, La., January 10, 1895, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Price per day for hire of snag boat.
1	Usner & Dawson, New Orleans, La	$94.50
2	Lyles & Allardyce, Burkeville, Tex	54.60
3	Moore & Bettis, Orange, Tex	74.80
4	Solliday & Cannon, Orange, Tex	50.00

Bids Nos. 1, 3, and 4 being informal, contract was awarded to Lyles & Allardyce, with the approval of the Chief of Engineers, at $54.60 per day. Contract dated February 6, 1895, and approved February 26, 1895. Work to be commenced July 1, 1895, and to be completed on or before January 1, 1896.

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	6
Net tonnage, registered	493
Trips made	523
Gross tonnage, 523 trips	257,839
Schooners	15
Net tonnage, registered	540
Trips made	62
Gross tonnage, 62 trips	33,480
Barges	10
Net tonnage	2,030
Trips made	145
Gross tonnage, 145 trips	29,435
Total vessels	31
Total net tonnage	3,063
Total trips	730
Total gross tonnage	320,754

Draft of heaviest vessel, light, 30 inches; loaded, 5 feet 6 inches.
No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Lumber	239,602	$1,047,305	179,628	$646,144
Cotton	1,170	151,000	249	28,500
Cotton seed	1,445	17,325	.....	.....
Staves	2,600	212,000	.....	.....
Wool	40	46,000	.....	.....
Merchandise	800	45,000	2,861	61,400
Total	245,657	1,518,630	182,738	736,044

The water was so very low in the Sabine River during the past year, and for so long a time, that steamboats could not run any great distance up above Orange, only two trips having been made up as far as Logansport.

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1893	146,363	$1,591,280
1894	245,657	1,518,630
1895	182,738	736,044

R 14.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873, and resurveyed from Bevilport to its mouth.

The project for improvement contemplated the dredging of a channel over the bar at the mouth and removal of obstructions from the river between Bevilport and Yellow Bluff.

In 1880 the bar at the mouth was dredged and a channel 5 feet deep and 30 to 60 feet wide was obtained. The obstructions in the river between Yellow Bluff and Bevilport were removed in 1882.

The original estimate of the cost of improvement was for work at the mouth of the river, $26,318.05; and for upriver, $15,000; a total of $41,318.05.

The bar at the mouth of the river again shoaled until at extreme low water there was a depth of about 3 feet over it.

At that time there was very little commerce passing in and out of the river, but as the bar at this place was the shoalest obstruction between the Gulf and Beaumont, Tex., and the money was available for dredging the bar, it was thought advisable to reopen this channel.

The Government dredge, which had completed work at the head of Calcasieu Pass, was placed in good repair and sent over to the mouth of the river in December, 1888, for the purpose of redredging the channel over the bar. By the 1st of May following the dredge had removed 55,482 cubic yards of material and completed a 5-foot channel on the line of the old one, of which traces still remained.

No dredging having been done since that time, the bar has shoaled to a depth of about 4 feet. Since the increased depth of water secured by the improvement at Sabine Pass, Tex., shipments of lumber from Beaumont to Sabine Pass have greatly increased, rendering this depth insufficient for the needs of the increased commerce. It is, therefore, contemplated to use the available funds in dredging a channel about 100 feet wide and fully 8 feet deep from deep water in the Neches River to deep water in Sabine Lake, the work to be done with the United States dredge after she shall have completed the channel through the bar at the mouth of Sabine River. The project for this work was approved March 29, 1895.

The total amount thus far expended upon the improvement of this river is $28,842.16, leaving still unexpended $4,157.84.

The dredged channel can not be expected to be permanent in such a broad and shallow body of water as Sabine Lake, but will probably serve all the necessities of the commerce using it for several years.

Abstract of appropriations for improving Neches River, Texas.

By act of Congress approved—	
June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	3,000
March 3, 1881	5,000
By act of Congress—	
Passed August 2, 1882	5,000
Approved July 5, 1884	7,000
Total	33,000

Money statement.

July 1, 1894, balance unexpended	$4,157.84
July 1, 1895, balance unexpended	4,157.84

COMMERCIAL STATISTICS.

[From June 1, 1894, to May 31, 1895.]

Steamers	4
Trips made	121
Gross tonnage, registered	12,834
Schooners	3
Trips made	15
Gross tonnage, registered	283
Barges	4
Trips made	15
Gross tonnage, registered	2,657
Total vessels	11
Total trips	151
Total tonnage	15,774

Draft of heaviest vessel, light, 2.6 feet; loaded, 4.6 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Lumber	164,319	$493,754	143,122	$405,090
Cotton	183	26,000	.....	.....
Hides	6	5,000	4	402
Wool	20	14,000	.....	.....
Cattle	200	15,000	110	3,000
Merchandise	800	40,000	515	52,528
Rice	.....	.....	2,867	83,700
Total	165,528	593,754	146,618	544,720

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1893	77,533	$600,410
1894	165,528	593,754
1895	146,618	544,720

Owing to the obstructions to commerce caused by sunken logs and stumps above Beaumont and the shallow water existing on the bars at the point where the river flows into Sabine Lake the commerce has been very much restricted.

R 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck of steamer Queen of the West in Grand Lake, Louisiana.—This wreck lies in or near the middle of Grand Lake, Louisiana, and has formed a serious obstruction to the navigation of the lake. It having been abandoned by the owners and sufficient time having elapsed it was recommended to be removed.

June 4, 1895, the Secretary of War authorized its removal and allotted therefor the sum of $1,200. It is proposed to do the work by contract, and specifications are now in course of preparation, preparatory to advertising for proposals.

R 16.

PRELIMINARY EXAMINATION OF BAYOU BONFUCA, IN ST. TAMMANY PARISH, LOUISIANA.

[Printed in House Ex. Doc. No. 273, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 28, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 22, 1895, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of Bayou Bonfuca, in St. Tammany Parish, La., made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Quinn states that the bayou is worthy of improvement, and he estimates that the survey necessary to preparation of plan of improvement, with estimate, will cost $700.

Col. C. B. Comstock, Corps of Engineers, Division Engineer, is of opinion that the bayou is worthy of improvement to a small extent, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 22, 1895.

GENERAL: In accordance with the instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report of a preliminary examination of Bayou Bonfuca, in St. Tammany Parish, La.:

This bayou flows into Lake Pontchartrain, and for a distance of about 15 miles from its mouth has a least depth of about 20 feet.

At the mouth there is a bar which has only about 4 feet of water on it at low tide. If this bar was deepened to 8 or 10 feet it would afford easy entrance to the bayou for the ordinary craft which plies upon Lake Pontchartrain and brings to New Orleans the commodities of the country through which this stream flows. There are a few snags obstructing the bayou which would require removing. Otherwise, the stream from the bar at its mouth to Slidel is in good condition.

From the annexed table of commercial statistics it appears that this bayou is worthy of improvement, and it is estimated that it would not cost more than $700 to make the requisite survey.

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Number of steamers	3
Number of trips made	290
Gross tonnage, registered	110
Gross tonnage, multiplied by number of trips	31,900
Number of schooners	21

Number of trips made	370
Gross tonnage, registered	324
Gross tonnage, multiplied by number of trips	119,880
Number of barges	2
Number of trips made	9
Gross tonnage	247
Total number of vessels	26
Total number of trips	689
Total tonnage, registered	681
Total tonnage of total number of trips	152,027

Receipts and shipments.

Articles.	Tons.	Value.
Lumber	31,000	$90,000
Bricks	3,375	10,500
Wood	4,040	8,080
Charcoal	225	1,875
Merchandise	800	35,000
Total	39,440	145,455

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, January 24, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated I think this stream worthy of improvement to a small extent.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

R 17.

PRELIMINARY EXAMINATION OF CHEFUNCTE RIVER AND BOGUE FALIA, LOUISIANA.

[Printed in House Ex. Doc. No. 274, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 30, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 24, 1895, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of Chefuncte River and Bogue Falia, Louisiana, made to comply with the requirements of the river and harbor act of August 17, 1894.

For the reasons stated Major Quinn is of the opinion that these streams are worthy of improvement by the General Government, and his opinion is concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office.

It is estimated that the survey necessary to the preparation of plan of improvement, with estimates, will cost $2,500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 24, 1895.

GENERAL: In reply to the letter from your office of August 20, 1894, relative to a preliminary examination of Chefuncte River and Bogue Falia, Louisiana, I have the honor to state that the Chefuncte River, of which Bogue Falia is a tributary, flows into Lake Pontchartrain, Louisiana, and is navigable up to Covington, La., a distance of about 12 miles.

The principal obstructions to navigation are two shoals situated near Covington, on Bogue Falia, and the bar at the mouth of the Chefuncte River. On account of these bars the steamers have to lighter their freight, thus greatly increasing the cost of transportation. These streams form the only water outlet for the products shipped and the goods consumed by the larger part of St. Tammany Parish. If the streams were opened a greater part of the freight would be shipped by water, as the distance from Covington to New Orleans would be only about 30 miles, as against 60 miles by railroad. Furthermore, these streams are navigable for some distance above their point of juncture, and, although not much commerce at present is transported over this portion, owing to sundry obstructions, which may admit of easy removal, it is believed that, on account of the increased amount of freight which would pass through these streams if they were improved, they are worthy of improvement.

The survey should extend from the mouth of the Chefuncte River to the Bogue Falia, and it is estimated that this survey would not cost more than $2,500.

Commercial statistics of these streams are appended.

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Number of steamers		12
Number of trips made		637
Gross tonnage, registered		414,687
Number of schooners		42
Number of trips made		287
Gross tonnage, registered		246,820
Number of barges		6
Number of trips made		75
Gross tonnage		9,400
Total number of vessels		62
Total number of trips		999
Total tonnage		670,907
Draft of heaviest vessel:		
Light	feet	5.6
Loaded	do	7.2

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber, shingles, and laths	8,314	$120,206	218,132	$462,838
Brick	4,405	16,571	8,750	28,000
Sand	11,776	15,702	6,870	9,160
Wood	234	410	536	1,206
Cotton	219	38,770	480	66,990
Rice	1,103	27,496	761	23,472
Miscellaneous	100	5,000	120	3,270
Sheep, horses, and cattle	101	7,386	426	11,000
Tar and rosin	124	2,730	125	1,368
Sirup	138	4,631	115	3,795
Pecans	8	1,488	4	600
Moss	8	296	6	240
Wool	4	940	3½	960
Total	26,534	241,626	236,328½	612,899
RECEIPTS.				
Merchandise	3,750	187,500	6,136	306,800
Grand total	30,284	429,126	242,464½	919,699

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, January 28, 1895.

Respectfully forwarded to the Chief of Engineers.
For the reasons stated by him, I concur in Major Quinn's opinion.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

R 18.

PRELIMINARY EXAMINATION OF TICKFAW RIVER AND TRIBUTARIES, LOUISIANA.

[Printed in House Ex. Doc. No. 284, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 1, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 28, 1895, of Maj. James B. Quinn, Corps of Engineers, of results of preliminary examination of Tickfaw River and tributaries, Louisiana, made to comply with provisions of the river and harbor act of August 17, 1894.

Major Quinn is of opinion that the Tickfaw and the Natalbany, its principal tributary, are worthy of improvement, and he estimates that the survey necessary to preparation of project of improvement, with estimates, will cost $1,500.

In the opinion of Col. C. B. Comstock, Corps of Engineers, division engineer, this stream is worthy of improvement to a small extent, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 28, 1895.

GENERAL: In accordance with the instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report of a preliminary examination of Tickfaw River and tributaries, Louisiana:

The Tickfaw River flows into Lake Maurepas, Louisiana, and is navigable for a distance of about 40 miles. It has a sufficient depth of water, the only obstructions being snags and overhanging trees. The principal tributary to the river is the Natalbany River, which flows into the Tickfaw about 3 miles above Lake Maurepas. This stream is navigable for a distance of 25 or 30 miles, and has sufficient water, but, like the Tickfaw, is obstructed by snags and overhanging trees.

On account of the great area of country which would be benefited by water communication through these streams, and as they could be placed in good condition at a very small cost to the Government, I recommend them as worthy of improvement.

The cost of a survey would be about $1,500.

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Number of steamers	6
Number of trips made	138
Gross tonnage, registered	68,448
Number of schooners	33
Number of trips made	126
Gross tonnage	87,066
Total number of vessels	39
Total number of trips	246
Total tonnage	155,514

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Wood	3,748	$5,355	2,452	$6,908
Lumber	8,314	113,020	33,370	120,899
Brick	845	4,573	711	2,212
Cotton	53	6,857	155	21,630
Merchandise	34	1,701	45	2,025
Total	12,994	131,506	36,733	153,674
RECEIPTS.				
Merchandise	1,000	38,137	3,270	98,100
Grand total	13,994	169,643	40,003	251,774

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, January 30, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Major Quinn, I think this stream is worthy of improvement to a small extent.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer

R 19.

PRELIMINARY EXAMINATION OF BAYOU TECHE, LOUISIANA, FROM ST. MARTINVILLE TO PORT BARRE.

[Printed in House Ex. Doc. No. 272, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 28, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 22, 1895, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of Bayou Teche, Louisiana, from St. Martinville to Port Barre, made to comply with provisions of the river and harbor act of August 17, 1894.

Major Quinn states that the bayou is worthy of improvement, provided this can be done at moderate cost, and he estimates that the survey necessary for preparation of plan of improvement, with estimate, will cost $1,500.

Col. C. B. Comstock, Corps of Engineers, division engineer, is of opinion that the bayou is worthy of improvement to a moderate extent, and I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 22, 1895.

GENERAL: Pursuant to instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report upon the preliminary examination of Bayou Teche, Louisiana, from St. Martinville to Port Barre.

Bayou Teche flows out of Bayou Courtableau at Port Barre, and flows into the Atchafalaya River. It is navigable from the Atchafalaya to St. Martinville at all seasons, but from St. Martinville to Port Barre, a distance of about 55 miles, it is navigable only during the high-water season, about six months, and during this time navigation is seriously obstructed by snags and overhanging trees.

This bayou flows through a very fertile and thickly settled country, and is at present the only means there is of transporting the products, except by wagon, to the railroad, a distance varying from 7 to 15 miles. On account of this way of shipping, no accurate commercial statistics could be obtained; but from the best information at hand it is estimated that during the fiscal year ending May 31, 1894, there was shipped and received about 60,000 tons of freight, consisting of rice, cotton, cotton seed, sugar, lumber, and general merchandise.

If water communication could be had the year round it would greatly reduce the cost of freight, besides furnishing a market for a great many products not shipped at present on account of the meager means of transportation. Providing this could be done at moderate cost, by dams or otherwise, I consider this stream worthy of improvement.

The cost of a survey would be about $1,500.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, January 24, 1895.

Respectfully forwarded to the Chief of Engineers.

I concur with Major Quinn that, for the reasons stated, this stream is worthy of improvement to a moderate extent.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

R 20.

PRELIMINARY EXAMINATION OF CHANNEL THROUGH SABINE LAKE, TEXAS, FROM THE MOUTH OF THE SABINE AND NECHES RIVERS TO THE HEAD OF THE PASS FROM SAID LAKE TO THE GULF OF MEXICO.

[Printed in House Ex. Doc. No. 275, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 30, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 24, 1895, by Maj. James B. Quinn, Corps of Engineers, of the results of a preliminary examination of channel through Sabine Lake, from the mouth of the Sabine and Neches rivers to the head of the pass from said lake to the Gulf of Mexico, made to comply with the provisions of the river and harbor act of August 17, 1894.

It is the opinion of Major Quinn, concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office, that the locality is worthy of improvement by the General Government.

It is estimated that the survey necessary to the preparation of plan of improvement, with estimates, will cost $2,500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 24, 1895.

GENERAL: In accordance with the instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report of a preliminary examination of channel through Sabine Lake, Texas, from the mouth of the Sabine and Neches rivers to the head of the pass from said lake to the Gulf of Mexico:

Sabine Lake, a part of the boundary between Texas and Louisiana, is about 18 miles long and has an average depth of about 7 feet, excepting at the mouths of the Sabine and Neches rivers, where the depths on the bars are about 4 feet, and at Blue Buck Bar, the head of Sabine Pass, where the depth is about 5 feet.

That this lake is worthy of improvement can be seen by referring to the copy of commercial statistics for Sabine Pass, Tex., for the fiscal year ending May 31, 1894, herewith attached. With the exception of the rock the greatest part of the commerce passing through Sabine Pass would pass through Sabine Lake if improved. The amount of produce will be enormously increased after the completion of the 24-foot channel at Sabine Pass, which will be by June, 1896.

The United States forestry report, issued by the Census Bureau, states that in Texas and Louisiana there are at least 8,000,000,000 feet of long-leaf pine which can be conveyed to the mills on the Sabine River more cheaply than to any other market. The waterway through Sabine Lake and Pass would be the most economical outlet for this lumber.

In addition to the lumber there is a rich agricultural country tributary to Sabine Lake and Pass which water communication would develop.

In view of the immediate prospects of deep water at Sabine Pass, and the large section to be benefited by the extension of deep water through Sabine Lake to the Sabine and Neches rivers, I think it worthy of improvement.

A complete survey with reference to this improvement would cost $2,500.

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Number of vessels	56
Trips made	97
Tonnage registered	15,850
Draft of heaviest vessel:	
Going in ..... feet..	16.3
Going out ..... do ..	17.5

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber	9,780	$117,060	28,892	$173,352
Merchandise	450	22,500	580	14,750
Total	10,230	139,560	29,472	188,102
RECEIPTS.				
Rock	3,290	9,870	13,774	43,387
Coal	950	3,800	2,700	11,800
Merchandise	500	25,000	1,020	36,900
Brick	80	2,720	.....	.....
Grand total	15,050	180,950	46,966	280,189
Increase over previous year	.....	.....	31,916	99,239

Respectfully submitted

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, January 28, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by him, I concur in Major Quinn's opinion.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

APPENDIX S.

REPORTS OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, UPON PRELIMINARY EXAMINATION OF BATON ROUGE HARBOR AND OF HARBOR AT BAYOU SARA, LOUISIANA.

S 1.

PRELIMINARY EXAMINATION OF BATON ROUGE HARBOR, LOUISIANA.

[Printed in House Ex. Doc. No. 71, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 21, 1894, by Capt. John Millis, Corps of Engineers, of the results of preliminary examination of the harbor at Baton Rouge, La., provided for by the river and harbor act of August 17, 1894.

It is the opinion of Captain Millis, concurred in by Col. C. B. Comstock, Corps of Engineers, the division engineer, and by this office, that this harbor is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 21, 1894.

GENERAL: I have the honor to submit the following report upon preliminary examinations, in accordance with instructions from the Chief of Engineers of August 20, 1894:

HARBOR AT BATON ROUGE, LA.

In my opinion this harbor is not worthy of improvement by the General Government. I base this opinion on the following facts and reasons:

Facts.—Baton Rouge is a town of about 14,000 inhabitants. It is the capital of Louisiana. It is situated on the east bank of the Mississippi

River, 130 miles above New Orleans. The greater portion of the town is on high land, but the street along the river front is about on a level with extreme high water in the river. There is one railroad here, the Yazoo and Mississippi Valley, owned and operated by the Illinois Central Railroad Company. The track passes along the water front close to the river bank.

There is one small wharf for steamboats, but the boats can land at the bank at almost any point along the river front. The river traffic is important, but is not increasing. From Main street to Florida street, a distance of about 600 feet, including two blocks in length, the bank, for a depth equal to nearly the width of the street along the river front, has a tendency to settle, a crack having appeared which in some places extends back to the curb line on the land side of the street. This has been going on for some years. The movement usually takes place after the high-water season, and appears to be greater after a large flood. The portion affected goes down bodily, though the settlement is somewhat greater near the curb line of the street than at the edge of the bank. Only the street and railroad track have been noticeably affected so far, though the movement has extended close up to the foundations of several brick buildings. It has been the custom to fill up the street and railroad bed each time the movement has taken place. The total maximum settlement and fill has been about 7 to 8 feet. There are a number of deep wells in the city and the city water system is supplied from such a well. These wells indicate strata of material underlying the town which are pervious to water and which are supplied from the hill country behind.

Reasons.—The difficulty above described which it is desired to remedy is a very common one wherever the river strikes the bluffs. It is not due entirely to the action of the river, and it is very doubtful if it could be remedied by any works in the river alone, except possibly at an expense which would not be justified by the value of the property and the interests affected. Such works would be of no direct or general benefit to navigation or to the present or prospective demands of commerce. So far as can be foreseen at present the water front of the city, omitting the portion affected by the settlement, will be ample for all needs of river commerce.

The examination was made by me in person on September 19, 1894.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, September 24, 1894.

Respectfully forwarded to the Chief of Engineers.

It would probably be cheaper for the United States to pay all damages arising from the slow settlement of this bank than to prevent it.

I concur in the opinion of the district engineer that it is not an improvement worthy of being made by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 2.

PRELIMINARY EXAMINATION OF HARBOR AT BAYOU SARA, LOUISIANA.

[Printed in House Ex. Doc. No. 63, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report dated September 21, 1894, by Capt. John Millis, Corps of Engineers, of the results of preliminary examination of harbor at Bayou Sara, Louisiana, provided for by the river and harbor act of August 17, 1894.

Captain Millis is of the opinion that this locality is not worthy of improvement by the General Government, and this opinion is concurred in by the division engineer, Col. C. B. Comstock, Corps of Engineers, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 21, 1894.

GENERAL: I have the honor to submit the following report upon preliminary examination, in accordance with instructions from the Chief of Engineers of August 20, 1894:

HARBOR AT BAYOU SARA, LOUISIANA.

In my opinion this harbor is not worthy of improvement by the General Government. I base this opinion on the following facts and reasons:

Facts.—Bayou Sara is situated on the east bank of the Mississippi River, 165 miles above New Orleans. It is on the bottom lands between the bluffs and the river and just below the mouth of a stream or bayou of the same name which flows into the Mississippi. The place is protected from overflow in high water by a levee which runs from the bluff along near the bank of the bayou on the upper side of the town to the main river, along the river bank to the lower side, and then back to the bluff.

At a point about 2,000 feet from the mouth the bayou makes an abrupt bend, and the bank here is caving, threatening the levee and private property in the immediate vicinity. The bayou goes nearly dry in low water. In high water logs are towed out, but otherwise there is no navigation on the bayou. The improvement desired is to stop the caving in the bend at the point described.

Reasons.—The work proposed would have no bearing, even remote, upon navigation or upon the demands of commerce, either present or prospective.

The examination was made by me in person on September 18, 1894.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, September 24, 1894.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion of the district officer, that this harbor is not worthy of improvement, for the reasons stated.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

APPENDIX T.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship Channel in Galveston Bay, Texas.
3. Channel in West Galveston Bay, Texas.
4. Trinity River, Texas.
5. Cedar Bayou, Texas.
6. Buffalo Bayou, Texas.
7. Harbor at Brazos Santiago, Tex.

EXAMINATIONS AND SURVEY.

8. Colorado River from the mouth to Wharton, Tex.
9. Gaudalupe River, Texas.
10. Bar and harbor at Brazos Santiago, Tex.
11. Brazos River, Texas, from Waco to Richmond.
12. Brazos River, Texas, from Velasco to Richmond.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 6, 1895.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

T 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The project for this improvement was adopted in 1874, modified in 1880, and again modified in 1886, the object being to deepen the channel so as to permit seagoing vessels of the deepest draft to enter the harbor.

The projects of 1874 and 1880 contemplated the construction of two jetties extending into the Gulf of Mexico, so as to concentrate the ebb flow upon the outer bar in the Gulf, and also to cause deepening of the inner bar at the entrance to Galveston Channel, these jetties to have their origins, respectively, at Bolivar Point and Fort Point.

More or less work was done under these projects. Under that of 1881 a jetty was built from Fort Point to the crest of the outer bar, but it was not fully completed.

The project of 1886 (that now in process of execution) also consists in the construction of jetties extending into the Gulf, one, the south jetty, starting from the east end of Galveston Island, and the other, the north jetty, starting from Bolivar Point opposite; or, to be more exact, the south jetty was to start from Fort Point, but in 1888 it was decided to connect the inner end of that jetty with the relatively high ground on which the city of Galveston is built by a stone dike known as the shore branch.

The jetties were to be of stone, built to an elevation of 5 feet above mean low tide, and to extend, if necessary, to the contour of 30-foot depth in the Gulf, their sea ends to be 7,000 feet apart, the action of the jetties to be supplemented, if need be, by dredging, the south jetty to follow the line of the jetty of 1881.

The natural depth upon the outer bar was 12 feet and that upon the inner bar 13 feet at mean low tide. The general plan of the work is shown upon the accompanying map.

At the close of the fiscal year ending June 30, 1894, the progress made in the construction of the jetties was as follows:

The south jetty had been completed for a distance of 32,000 feet and an apron 829 feet long was constructed at the sea end to prevent scour. This jetty having reached the outer crest of the bar, its farther extension was suspended for the time being.

The north jetty, commenced in April, 1893, had been completed for a distance of 10,000 feet, in addition to which 6,200 feet had been partially constructed.

The effect of this work was plainly shown on the bar, the inner one having entirely disappeared and the depth on the outer one having increased from 12 to 14½ feet, a gain of 2½ feet.

During the present fiscal year operations were carried on as follows:

The construction of the north jetty was continued, the south jetty trestle was repaired and partly rebuilt, a dredge was employed to assist the action of the jetties in removing the bar, a self-propelling suction dredge was in process of construction for this work, and tidal observations were made.

NORTH JETTY.

Rapid progress was made in the construction of this jetty, it having been completed for a distance of 18,500 feet, an advance of 8,500 feet during the year, and partially completed for a distance of 4,000 feet. Its present total length is 22,500 feet, and approximately 4,900 feet remains to be constructed before the 30-foot curve in the Gulf is reached.

SOUTH JETTY.

Operations on this jetty consisted, principally, in repairing the damage to the trestle, due to the ravages of the teredo, in order that its extension might be resumed at an early date.

From Station 84 to 194, a distance of 11,000 feet, the old trestle was blocked up, and relaid with new steel rails on cross-ties. From Station 194 to 320, a distance of 12,600 feet, a new trestle was in process of construction, parallel to and along the north side of the jetty, new piling and all serviceable material from the old structure being used in its erection.

It was also found necessary to raise a portion of this jetty, which contained a clay core, on account of a settlement which had taken place.

This jetty is completed to Station 320, a distance of 32,000 feet, and 5,100 feet remains to be constructed before the outer 30-foot contour is reached.

The total length of the jetties constructed since work was begun in 1887 is—

	Linear feet.
South jetty, completed	32,000
South jetty, uncompleted	829
North jetty, completed	18,500
North jetty, uncompleted	4,000
Total, June 30, 1895	55,329

An account in detail of the season's operations is shown in the accompanying report of Mr. E. M. Hartrick, assistant engineer, to which reference is made.

DREDGING.

A contract was entered into with O'Connor & Smoot, of Galveston, Tex., to dredge at least 100,000 cubic yards of material from the channel across the bar in order to hasten the work of securing deep water for this harbor, the price being 35 cents per cubic yard, scow measurement.

The plant furnished by the contractors consisted of the suction dredge *Jumbo*, equipped with three 12-inch centrifugal pumps and 10-inch discharge and a hopper capacity of 713 cubic yards. The dredge, not being self-propelling, was towed by the tug *Nimrod*.

Dredging was commenced on April 11, 1895, and up to the close of the year 68,071 cubic yards of material had been removed.

DREDGE BOAT GEN. C. B. COMSTOCK.

On October 6, 1894, a contract was entered into with the Bucyrus Steam Shovel and Dredge Company for the construction of a self-propelling suction dredge, with a carrying capacity of 500 cubic yards of sand; draft when loaded not to exceed 12 feet, and vessel to make a speed of 10 statute miles per hour when light and 7 statute miles when loaded.

The construction of the vessel is well advanced; the hull was launched on May 25, 1895, and the boilers and principal machinery have been set up. It is expected that the vessel will be finished and ready to start for Galveston about July 15.

TIDAL OBSERVATIONS.

These observations were continued throughout the year, three automatic tide gauges having been in operation, and were placed in charge of Lieut. William V. Judson, Corps of Engineers, whose report is forwarded herewith and to which attention is invited.

RESULTS OF THE WORK DURING THE FISCAL YEAR.

The usual annual survey of the bar and channel, as well as of the harbor generally, was made in May and June, 1895.

This survey shows that a marked change has taken place in the outer bar, due to the rapid extension of the north jetty. The 12-foot curve has entirely disappeared, the inner 18-foot curve has advanced 5,400 feet into the Gulf, while the corresponding advance of the outer 18-foot curve has been 1,800 feet, the distance between these curves at the narrowest part being 220 feet.

This rapid pushing out of the inner 18-foot curve has caused the formation of a new channel across the bar, known as the "East Channel," which was first used by vessels on November 15, 1894.

This channel is 340 feet wide and has a least depth of 17¾ feet. Last year the least depth through this channel was 12¾ feet, a gain of 5 feet in twelve months.

The 18-foot curves in the old channel, the "Southeast Channel," used by vessels until November 15, 1894, have approached each other 3,900 feet, leaving between them a bar 1,000 feet wide, over which there is a depth of 16¼ feet as against 14½ feet last year, a gain of 1¾ feet during the year.

The principal changes in the position of contours since June 30, 1894, are shown on accompanying map, on which the soundings are reduced to the plane of mean low tide, and are as follows:

The advance of the inner 24-foot and 30-foot curves has been small; the maximum advance of the outer 24-foot and 30-foot curves has been 1,200 feet, and is in the prolongation of the "East Channel."

Amount expended under all projects to June 30, 1894	$4,368,346.50
Amount expended during fiscal year ending June 30, 1895	1,222,623.99
Total expended to June 30, 1895	5,590,970.49

In addition to which the sum of $100,000, subscribed by the city of Galveston in 1883, was expended.

The work is located in the collection district of Galveston. The nearest lighthouses are at Bolivar Point and Fort Point at the entrance to Galveston Bay.

Abstract of appropriations made by Congress for improving harbor at Galveston, Tex.

By act of—		By act of—	
July 11, 1870	$25,000	August 2, 1882	$300,000
March 3, 1871	20,000	August 5, 1886	300,000
June 10, 1872	31,000	August 11, 1888	500,000
June 23, 1874	60,000	September 19, 1890	500,000
March 3, 1875	150,000	March 3, 1891	600,000
August 14, 1876	142,000	August 5, 1892	450,000
June 7, 1878	75,000	March 3, 1893	1,000,000
June 18, 1878	50,000	August 18, 1894	600,000
March 3, 1879	100,000	January 25, 1895	200,000
June 14, 1880	175,000	March 2, 1895	1,160,000
March 3, 1881	250,000		
March 4, 1882	100,000	Total	6,788,000

Money statement.

July 1, 1894, balance unexpended		$459,653.50
Amount appropriated by sundry civil act approved August 18, 1894		600,000.00
Amount appropriated by general deficiency act approved January 25, 1895		200,000 00
Amount appropriated by sundry civil act approved March 2, 1895		1,160,000.00
		2,419,653.50
June 30, 1895, amount expended during fiscal year		1,222,623.99
July 1, 1895, balance unexpended		1,197,029.51
July 1, 1895, outstanding liabilities	$157,311.27	
July 1, 1895, amount covered by uncompleted contracts	978,331.63	
		1,135,642.90
July 1, 1895, balance available		61,386.61
Amount (estimated) required for completion of existing project		1,690,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		1,690,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals received by Maj. A. M. Miller, Corps of Engineers, for constructing a hydraulic dredge for use at Galveston, Tex.

Name.	Kind of dredge.	Price.
Bucyrus Steam Shoveland Dredge Co., South Milwaukee, Wis.	With steel hull and triple expansion engines	$98,500
	With steel hull and compound engines	93,500
	With wooden hull and triple expansion engines	91,000
	With wooden hull and compound engines	*86,000
The Atlantic Works, East Boston, Mass.	With wooden hull and compound engines	94,586
The Charles Hillman Ship and Engine Building Co., Philadelphia, Pa.	With steel hull and compound engines	118,000
	With wooden hull and compound engines	105,000
Wm. E. Woodall & Co., Baltimore, Md.	With wooden hull and triple expansion engines	93,000
	With wooden hull and compound engines	89,500

*This bid accepted.

REPORT OF FIRST LIEUT. WILLIAM V. JUDSON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1895.

MAJOR: I have the honor to report as follows upon tidal observations at Galveston Harbor during the fiscal year ending June 30, 1895. This duty was among others assigned me by you on November 28, 1894.

My first effort was to bring up to date the plotting of the records from the automatic gauges, which was from one to two years behind. This has been accomplished, and it is proposed hereafter to have the plotting keep pace with the receipt of records from gauges.

During the year three automatic gauges were in operation, one on the Bar, one in the Gorge, and one at Government Wharf. These gauges are described in detail in former published reports.

During the year there was the usual percentage of lost records due to storms, ice, etc.

The following deductions have been made from the plotted records:

(1) By a monthly application of Mitchell's rule it was ascertained that no change occurred during the year in the level of any of the zeros of gauges except in the case of the Bar gauge, which latter was lowered by settlement about 0.261.

(2) The mean retardations were noted for each month beginning with July, 1893, when north jetty was started. The retardations are plotted as ordinates of a curve, in which the abscissæ represent time in months from July, 1893, the idea being to show what additional delay occurred at Gorge and Government Wharf, as the tidal flow was restricted more and more each month by the advancing north jetty.

(3). For each month during the same period of time a ratio was worked out between the mean fluctuations at the Bar, at the Gorge, and at the Government Wharf.

These ratios were plotted in a curve similar to the one above mentioned, for the purpose of ascertaining to what extent, if any, the jetties were effecting fluctuations within the bay.

It is believed that these curves need no further explanation than the one here given.

During the next fiscal year a current and direction meter will probably be in the possession of this office, and it is proposed to gather data that may effectually settle the question of litoral currents, both as to direction, duration, and velocity. Also as well as possible with one meter the tidal flow through the jetties will be gauged.

Very respectfully, you obedient servant,

WM. V. JUDSON,
First Lieut., Corps of Engineers.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1895.

MAJOR: I have the honor to submit the following report of operations for improving Galveston Harbor, Texas, during the fiscal year ending June 30, 1895:

SOUTH JETTY.

Condition of work on south jetty at beginning of fiscal year was the same as the previous year, viz, completed to Station 320 with a riprap apron to Station 328+39. At the end of fiscal year the jetty was in same condition, except genera l settlemen

and consolidation of jetty and deterioration of trestle and track. The repairs on trestle and track are complete to Station 280, with an incomplete portion to Station 311.

Casualties.—That portion of the trestle and track between Station 320 and end of apron at Station 328+39 had been more or less destroyed by the *Teredo navalis* honeycombing the piles. Nearly the whole superstructure was then carried away by storm waves and drift.

The outer end of completed jetty has also settled to a greater extent than the other portion of the work from scour undermining the riprap mound.

General progress and advance of the work.—Last year the repairs had been completed to Station 84 by taking off the rails, which had been laid on stringers, and relaying track with cross-ties on old stringers, all properly drift bolted, strapped, and spiked. The caps and stringers had also to be bedded in the riprap mound and properly blocked up and shimmed.

This year the work was continued from Station 84 to Station 194, using the same method, but relaying with new steel rails. From Station 194 the track turns out from the jetty and is constructed alongside and parallel to the jetty on its north side. New piles are being driven, the contractors using all the old material that can be utilized. The repairs have been retarded by lack of proper labor, mechanical appliances, and material.

Over that portion of the jetty which has a clay core it was found necessary, after the blocking had been set, to protect it with extra riprap on account of the settlement which had occurred at that place. This riprap surrounds and holds in place the blocking and brings the crest to about its original height above mean low tide.

At Fort Point a new railway-track scales was put in place in March, 1895, on the old foundation. The scales previously used in weighing stone for south jetty had been sent to Clinton to weigh granite block for jetties.

NORTH JETTY.

Condition of work on north jetty at beginning of fiscal year: Jetty complete to Station 100, riprap mound at mean low tide and partially protected with granite block to Station 125, trestle, track, and apron to Station 162. At the end of fiscal year jetty was complete to Station 185, an advance of 8,500 feet, at mean low tide to Station 201, trestle, track, and apron to Station 225, an advance of 6,300 feet.

Casualties.—The completed work remains about the same, but that portion undergoing construction, especially the riprap mound, was continually being consolidated and flattened from wave action, thereby giving a greater cross section than was contemplated. This would not have occurred to so great an extent if the granite block had been unloaded on slope as the work advanced; but, as stated in my last report, this is no detriment to the work, but an advantage, considered irrespective of cost.

Total suspension of work on both jetties occurred on the 5th, 7th, 11th, 14th, and 15th of February, 1895, from a succession of northerly gales accompanied with frost, cold, snow, and rain. Floating derricks and barges had to be towed in and anchored for safety under the lee of Bolivar, Fort Point, and Pelican Flats.

General progress and advance of the work.—The work has been more or less retarded by boisterous weather, together with lack of floating tonnage to transport granite block. The floating derricks also gave trouble, not having sufficient power to handle the block; constant repairs were needed and total collapse sometimes occurred. The want of another floating derrick with greater capacity is more apparent than ever, and will be still more obvious when the handling of blocks of not less than 10 tons becomes necessary. Having to cull riprap not up to specifications also retards the progress of the work, by delaying the trains that ought to be forwarded direct to the front.

INSPECTION, CONSTRUCTION, TRANSFER, AND BARGE LINE.

The general method of inspection and construction remains the same as explained in previous reports. (See Appendix U, Reports of Chief of Engineers for 1892 and 1893.) Operation of transfer and barge line as explained in Appendix U, Reports of Chief of Engineers for 1893 and 1894.

DREDGING ON THE OUTER BAR.

The *Jumbo* is a suction dredge or hydraulic drag, depending on the teeth of the drag to stir up the material; it has three centrifugal pumps, 12-inch suction and 10-inch discharge. Carrying capacity, 713 cubic yards, but only averaged 540 cubic yards.

The dredge is not self-propelling and has to be towed. The tug has not power enough to tow against head wind and strong current, so that only a few loads in twenty-four hours can be removed.

RESERVATION FENCE.

Government reservation fence at Fort Point was erected in March, 1895, and is completed from Galveston Channel to the Gulf of Mexico as far as the quicksand foundation would permit. It is built on the line as determined by Col. O. H. Ernst in 1888, located and established with cedar posts by Maj. Charles J. Allen in 1890.

NORTH JETTY.

TABLE NO. 1.—*Showing kind and amount of stone placed in north jetty.*

Month.	Cars.	Riprap.	Cars.	Block.	Total cars.
1894.		*Tons.*		*Tons.*	
July	1,275	27,935.17	372	9,977.64	1,647
August	726	14,906.25	503	12,707.20	1,229
September	1,313	29,375.79	168	4,224.75	1,481
October	1,276	27,933.24	327	8,346.01	1,603
November	1,227	27,881.32	392	10,234.47	1,619
December	1,118	24,878.46	362	8,913.16	1,480
1895.					
January	904	20,060.63	211	5,232.12	1,115
February	553	11,874.59	146	3,629.46	699
March	459	10,120.10	307	7,597.63	766
April	326	7,530.51	509	12,687.77	835
May	240	5,072.43	406	10,259.40	646
June	399	8,149.23	430	10,676.77	829
Total	9,816	215,717.72	4,133	104,486.38	13,949

TABLE NO. 2.—*Showing average cost per linear foot between stations.*

[Cost does not include office and inspection expenses.]

Stations.	Distance.	Depth of water. Max.	Depth of water. Min.	Cost per linear foot.	Remarks.
	Feet.	*Feet.*	*Feet.*		
0 to 15	1,500			$15.53	Shore branch.
15 to 20	500	8	0.5	35.68	Granite on crest; none on slope.
20 to 30	1,000	11	7.5	67.65	Granite on crest and on slope from Station 24.
30 to 40	1,000	11.5	9	69.60	
40 to 50	1,000	11.5	9.5	71.27	
50 to 60	1,000	11.5	6.5	66.53	
60 to 70	1,000	8	5.	70.06	Quicksand reef.
70 to 80	1,000	9	6.5	76.51	
80 to 90	1,000	12.5	9	100.96	
90 to 100	1,000	15	11	113.34	
100 to 110	1,000	19	15	124.82	
110 to 120	1,000	18	16.25	126.90	
120 to 130	1,000	21	17.25	138.88	
130 to 140	1,000	19	16	128.28	
140 to 150	1,000	16.5	16	135.83	
150 to 160	1,000	16.5	15	122.96	
160 to 170	1,000	16.4	16.10	125.99	
170 to 180	1,000	19	16	152.95	
180 to 190	1,000	17	15.50	147.56	Granite complete to Station 185; unloaded but not placed, Station 190.
190 to 200	1,000	19	11.50	108.15	Granite unloaded on slope only.

SOUTH JETTY.

TABLE NO. 3.—*Showing average cost per linear foot between stations.*

[Cost does not include office and inspection expenses.]

Stations.	Distance.	Average depth of water.	Cost per linear foot.	Remarks.
	Feet.	*Feet.*		
0 to 79+64	7,964		$19.44	Shore connection across old channel; average height, 1.07 feet above mean low tide.
79+64 to 84+64	500	3	34.26	
84+64 to 95+64	1,100	2.45	28.50	
95+64 to 107+64	1,200	1.50	36.47	Clay core.
107+64 to 138+64*	3,100	5.70	72.32	Do.
138+64 to 144+12	548	9.50	73.49	Do.
144+12 to 150	588	7.50	60.50	
150 to 160	1,000	7.30	56.59	
160 to 170	1,000	8.65	55.63	
170 to 180	1,000	7	40.49	
180 to 190	1,000	7.50	43.74	
190 to 200	1,000	10.95	79.25	Granite protection from Station 194.
200 to 210	1,000	10.35	81.31	
210 to 220	1,000	9.60	76.07	
220 to 230	1,000	7	72.65	
230 to 240	1,000	8.70	76.76	
240 to 250	1,000	9	80.60	
250 to 260	1,000	9.30	82.90	
260 to 270	1,000	10.20	89.86	
270 to 280	1,000	9.10	80.06	
280 to 290	1,000	9.20	72.19	
290 to 300	1,000	9.10	76.44	
300 to 310	1,000	10.10	76.87	End of mattress.
310 to 320	1,000	16.50	128.22	Sand foundation.
320 to 328+39†	839	15.10	24.93	839 feet of apron.

*Twenty-seven cars sandstone riprap were unloaded between Stations 120 and 133 to bring up center.
†Apron about 5 feet thick and 35 feet wide. All riprap; no granite.

DREDGING ON OUTER BAR.

TABLE NO. 4.—*Showing amount of material removed.*

	Loads.	Cubic yards.
Dredge Jumbo:		
April, 1895	26	12,829.20
May, 1895	39	20,922.90
June, 1895	60	34,319.10
Total	125	68,071.20

Annual survey.—The annual survey was commenced in May and completed in June, 1895. All heights above and soundings below are expressed in feet, and show the height above and depth below mean low tide.

South jetty.—Levels were taken over the axis of jetty every 7½ feet from Station 0 to Station 320, then by sounding rod over the submerged apron to Station 328 + 39; cross sections, by sounding, were taken every 1,000 feet at right angles and extending out 100 feet on both sides of jetty. By comparing with last years' report, the jetty has slightly settled between Stations 80 and 119; between Stations 119 and 133 the crest has been raised from 1 to 3 feet by unloading riprap over that portion having a clay core and had settled; between Stations 133 and 240 no change is observed; between Stations 240 and 313 a slight settlement, from one-fourth to three-fourths of a foot, and from Station 313 to Station 320 from one-half to 1 foot. The apron has also settled a few feet and is covered with sand at its extreme end and toe of slope. There has been a general accretion of sand on both sides and against the jetty, the north side averaging a 3-foot fill and south side 2 feet. The jetty is in a fair condition, except the outer 500 feet, which has more or less subsided, the granite block covering presenting a ragged appearance.

The Gulf shore line on Galveston Island remains about the same from Twenty-fifth street to Sixth street, but has advanced gulfward from 200 to 300 feet from Sixth street to South Jetty.

North jetty.—The profile and cross sections over completed work are taken from month to month as the work advances, immediately after the crest block has been

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put in place. Little settlement is noted, as time must elapse before any decided change can be observed. The complete work reported in last fiscal year to Station 100 shows a general settlement or consolidation from one-half to three-fourths of a foot from the shore to that station. There has been a general scour, leaving a trench on both sides of and close to the toe of the slope, except between the shore and Station 50 and between Stations 80 and 90 on the north side. In time, if the forces at work are the same as on south jetty, the trench will fill to a greater or less degree.

Bolivar shore line has advanced gulfward in the immediate vicinity of and north of north jetty with a decided accretion in the angle formed by this shore line and north jetty.

The storms of January, 1894, and February, 1895, displaced a few granite blocks; the waves worked the riprap from under the blocks before that section of the mound could be properly completed with the granite covering.

Outer bar.—The outer bar shows a marked change in the last twelve months. The 12-foot curve has completely disappeared from the bar; the 18-foot curve inside the bar has advanced 5,400 feet toward deep water in the Gulf, impinges against and is trained along north jetty 8,600 feet, when last year it only touched it for 2,200 feet. The outer 18-foot curve has advanced 1,800 feet, leaving a narrow 220-foot bar in the East Channel over which there is a navigable depth of 17¾ feet, against 12¾ feet last year, a gain in this channel of 5 feet and to the port of 3½ feet. Except for this narrow bar there is a channel 340 feet wide between the 18-foot curves, with an average depth of 20 feet and maximum of 22½ feet. This East Channel varies in depth from one-fourth to three-fourths of a foot according to direction and velocity of sand-bearing currents. In the old Southeast Channel the 18-foot curves have approached one another 3,900 feet, leaving a bar of 1,000 feet, over which there is a channel depth of 16½ feet, as against 14½ feet in last year's reports a gain of 1¾ feet in this channel with a straight southeast course over the bar.

The 24-foot curve inside the bar has advanced slightly, and at its outer end it has widened several hundred feet. Around the end of south jetty apron there is also a well-defined 24-foot curve, with a maximum depth of 25½ feet.

The 30-foot curve remains about the same inside the bar. The general advance of the outer curves is as follows, measured on the axis of proposed extension of jetties and axis of East Channel, viz:

	Feet.
Axis of north jetty 18-foot curve	500
Axis of north jetty 24-foot curve	300
Axis of north jetty 30-foot curve	800
Axis of south jetty 18-foot curve.	
Axis of south jetty 24-foot curve	750
Axis of south jetty 30-foot curve	1,150
Axis of East Channel 18-foot curve	1,800
Axis of East Channel 24-foot curve	1,200
Axis of East Channel 30-foot curve	1,200

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1895.

Tonnage of vessels and revenue collected.

	Steam vessels.	Sailing vessels.	Total.	Total tonnage.
Entered	424	176	600	744,275
Cleared	426	121	547	708,557
Total	850	297	1,147	1,452,832

Duties on imports collected $65,911.48

Amount and value of freight shipped.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (1,609,538 bales)	402,385	$49,520,000	$3,000,000
Cotton products	125,172	2,418,000	625,800
Ore	1,000	94,000	5,700
Wool	7,337	954,000	63,000
Grain	1,317	26,000	4,500
Miscellaneous	288,914	3,939,000	1,596,000
Total	826,125	56,951,000	6,195,000

Increase of freight carried over last year, 309,446 tons.

Comparative statement of commercial statistics of the port of Galveston, Tex., for fiscal years 1890 to 1895.

Year.	Vessels entered.		Vessels cleared.		Tonnage.		Total.
	Steam.	Sailing.	Steam.	Sailing.	Entered.	Cleared.	
1890	302	145	304	118	501,695	492,677	999,372
1891	242	139	345	96	544,862	529,058	1,073,920
1892	345	137	342	62	587,216	547,110	1,134,326
1893	300	114	295	36	497,150	489,563	986,713
1894	295	165	252	141	524,789	462,487	987,276
1895	424	170	426	121	744,275	708,557	1,452,832

Transported.

Year.	Cotton.	Cotton products.	Corn and wheat.	Ore.	Wool.	General merchandise.	Total weight.	Total value
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
1890	223,486	79,140	.....	.....	6,883	.....	309,509	$51,558,115
1891	258,638	44,182	.....	6,923	6,847	140,280	456,618	59,634,000
1892	287,377	62,114	23,068	8,100	6,974	57,780	445,413	51,260,000
1893	242,515	82,898	36,330	1,418	3,832	33,450	400,353	51,250,000
1894	239,183	80,474	10,949	531	5,542	180,000	516,679	44,003,000
1895	402,385	125,172	1,317	1,000	7,337	288,914	826,125	56,951,000

T 2.

IMPROVEMENT OF SHIP CHANNEL IN GALVESTON BAY, TEXAS.

The ship channel in Galveston Bay extends from Bolivar Channel at the lower end of Galveston Bay to Morgan Canal at the northwest corner of that body of water. It is mainly a dredged channel and was formerly known under two names, the lower end as the "Ship Channel," 18.9 miles long, and the upper end as the "Morgan Cut," 4.8 miles long. Morgan Canal, 0.63 mile long, connects Galveston Bay with the enlargement of San Jacinto River known as San Jacinto Bay. This channel is one link in a waterway connecting Houston with the Gulf of Mexico, the other links being the San Jacinto River and Buffalo Bayou.

The original project, adopted in 1871 and modified in 1877, contemplated the maintenance of a channel at least 100 feet wide at the bottom and 12 feet deep over the portion formerly known as the "Ship Channel," the upper portion, known as "Morgan Cut and Canal," being in the hands of private parties. In 1892 the United States secured possession of the "Morgan Cut and Canal," and the project submitted in that year contemplated maintaining a channel at least 100 feet wide and 12 feet deep from Bolivar Channel to the upper end of Morgan Canal, the channel to be suitably marked by beacons.

At the close of the last fiscal year the lower portion of the channel extending from Bolivar Channel to Morgan Beacon which had previously been dredged to the desired width and depth had shoaled considerably owing to suspension of operations for several years. Of the upper portion, extending from Morgan Beacon to the mouth of the canal, 19,000 linear feet were dredged during the year, of which length 4,000 feet was 100 feet wide and 15,000 feet was 75 feet wide, the depth throughout being 9.5 feet at mean low tide.

This work was still in progress at the commencement of the present year under contract with the Rittenhouse Moore Dredging Company, of Mobile, Ala., and was continued until contract was completed on September 13, 1894. At that time a channel, having a depth of 9.5 feet and width of at least 75 feet, had been dredged from Morgan Beacon to Morgan Canal. The amount of material removed from July 1 to September 13 under this contract was 75,585 cubic yards.

An appropriation of $50,000 having been made by act of August 17, 1894, for continuing this work, a contract was entered into on December 8, 1894, with Charles Clarke & Co., of Galveston, Tex., for doing the necessary dredging.

It was proposed to at first widen the channel excavated under the former contract, from 75 to 150 feet, with a uniform depth of 9.5 feet, and when this was completed to deepen as wide a portion of the channel from 9.5 to 12 feet as the available funds would permit.

This widening to 150 feet was commenced January 11, and was completed on May 2, 1895, the amount of material removed having been 130,119 cubic yards.

Upon completion of this work it was found that the funds then available were sufficient to deepen the channel, for a width of 75 feet, from 9.5 to 12 feet. This work was commenced on May 3, and by June 30 20,700 linear feet of cut, 40 feet wide and 12 feet deep at mean low tide, had been completed, requiring the removal of 93,628 cubic yards of material.

The total amount of material dredged during the fiscal year was 299,332 cubic yards.

The details of the season's operations are shown in the report of Mr. Donald Allen, assistant engineer, which is forwarded herewith.

It is not practicable to give the statistics of the commerce of the ship channel. Almost the entire floating commerce of Buffalo Bayou, Trinity River, and Cedar Bayou is carried through this channel, and the commercial statistics are given in the reports for those works. The number of vessels passing through Morgan Canal during the year was 1,820, of which 912 were north bound and 908 were south bound.

It is believed by many of the best informed men of Houston that the advantages to be derived from enabling seagoing ships to reach Houston by way of the ship channel and Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. The annual report of Buffalo Bayou gives as full statistics of the freight carried upon that stream as could be obtained. It is carried in barges drawing 5 feet when full loaded and towed by tugs drawing 7 feet and less. These cross Galveston Bay, where the depth of water is already sufficient for them. A large portion of this freight would be loaded directly upon seagoing vessels if they visited Houston. One item of shipment by water down Buffalo Bayou from Houston during the past fiscal year was 514,021 bales of cotton.

Amount expended to June 30, 1894	$597,648.58
Amount expended during present fiscal year	51,858.28
Total amount expended to June 30, 1895	649,506.86

Abstract of appropriations made by Congress for improving ship channel in Galveston Bay, Texas.

By act of—		By act of—	
March 3, 1875	$25,000	August 11, 1888	$100,000
August 4, 1876	72,000	September 19, 1890	40,000
June 18, 1878	75,000	July 13, 1892	40,000
March 3, 1879	80,000	August 17, 1894	50,000
June 14, 1880	50,000		
March 3, 1881	50,000	Total	676,500
August 2, 1882	94,500		

The amount that can be profitably expended during the fiscal year ending June 30, 1897, is $200,000, to be applied to dredging.

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half-Moon Shoal, and Red-fish Bar.

Money statement.

July 1, 1894, balance unexpended		$28,851.42
Amount appropriated by act of August 17, 1894		50,000.00
		78,851.42
June 30, 1895, amount expended during fiscal year		51,858.28
July 1, 1895, balance unexpended		26,993.14
July 1, 1895, outstanding liabilities	$8,826.29	
July 1, 1895, amount covered by uncompleted contracts	16,869.07	
		25,695.36
July 1, 1895, balance available		1,297.78
Amount (estimated) required for completion of existing project		219,675.44
Amount that can be profitably expended in fiscal year ending June 30, 1897		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals for dredging ship channel in Galveston Bay, Texas, received in response to advertisement dated October 27, 1894, and opened November 27, 1894, at Galveston, Tex., by Maj. A. M. Miller, Corps of Engineers.

No.	Name and address of bidder.	Dredging 150,000 cubic yards, more or less, per cubic yard.	Amount.
		Cents.	
1	Rittenhouse Moore Dredging Co., Mobile, Ala.	13	$19,500
2	Charles Clarke and Robert P. Clarke, Galveston, Tex.*	12½	18,750

* Lowest bid; acceptance recommended.

REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 3, 1895.

MAJOR: I have the honor to submit the following report of operations for the improvement of ship channel in Galveston Bay, Texas, for the fiscal year ending June 30, 1895:

The ruling depth from Bolivar Channel to Morgan Beacon is 8.5 feet. The average depth is 9.5 feet, and the ruling depth from Morgan Beacon to Morgan Canal is 9.5 feet. Through Morgan Canal the depth remains about the same as last year.

Dredging.—The Rittenhouse Moore Dredging Company, of Mobile, Ala., under their contract of March 21, 1893, continued dredging in Morgan Cut until September

13, 1894, when the appropriation was exhausted. The amount of material dredged between July 1, 1894, and September 13, 1894, was 75,585 cubic yards.

By the removal of this material there was dredged 5,800 linear feet of channel 75 feet wide, 9½ feet deep at mean low tide, extending from the north end of the channel previously dredged (at Pile 19) to the 9½-foot depth at the south end of Morgan Canal, also a strip 25 feet wide, 9½ feet deep at mean low tide, on the east edge of the 75-foot channel previously dredged (making this channel 100 feet wide), extending from the mouth of Morgan Canal, a distance of 12,720 linear feet, to Pile 12+80.

The total amount of material dredged from Morgan Cut under the contract with the Rittenhouse Moore Dredging Company was—

	Cubic yards.
Fiscal year 1894	153,376
Fiscal year 1895	75,585
Total	228,961

and the total length of channel completed is 24,800 linear feet. Of this 8,080 linear feet is 75 feet wide and 16,720 linear feet is 100 feet wide, 9½ feet deep, at mean low tide. This channel extends from Morgan Beacon to the 9½-foot depth in Morgan Canal.

A contract with Charles Clarke & Co., of Galveston, Tex., was entered into December 8, 1894, to widen the channel from Morgan Beacon to Morgan Canal to a uniform width of 150 feet, with 9½ feet depth mean low tide, and in the center of this dredged channel for the width of 75 feet, to dredge to an additional depth, giving 12 feet at mean low tide.

Charles Clarke & Co. commenced dredging at Morgan Beacon January 11, 1895, to widen the channel to a uniform width of 150 feet, with 9½ feet depth at mean low tide. This part of the work was completed May 2, 1895; 130,119 cubic yards were dredged in accomplishing the same.

Dredging was then commenced at Morgan Beacon in the center of the 150-foot channel already dredged, and a cut 40 feet wide, 20,700 feet long, 12 feet deep at mean low tide was dredged extending toward Morgan Canal and reaching within 4,100 feet of the same by June 30, 1895; 93,628 cubic yards were removed in dredging the same.

The total amount of material dredged from Morgan Cut during the fiscal year 1895, under contract with Rittenhouse Moore Dredging Company, 75,585 cubic yards; under contract with Charles Clarke & Co., 223,747 cubic yards; total, 299,332 cubic yards.

There now extends a dredged channel from Morgan Beacon to Morgan Canal 150 feet wide, 9½ feet deep at mean low tide, with a cut in the center of the same extending from Morgan Beacon toward Morgan Canal 20,700 feet, 40 feet wide, and 12 feet deep at mean low tide.

There remains to be dredged to complete the work contemplated under this contract a cut of 4,100 feet long, 40 feet wide, and a cut 24,800 feet long, 35 feet wide, and 12 feet deep at mean low tide.

Beacons.—During the past year six of the ship channel 3-pile beacons, Nos. 1, 8, 9, 10, 11, and 13, and upper bay beacon (4-pile) "UBB" were destroyed. Three-pile beacons, Nos. 3, 12, and 16, have been pushed to a leaning position by passing tugs with long tows of cotton and granite, which they could not control in rough weather, and will have to be rebuilt.

Tug Dorothy.—During March and April, 1895, two worn-out feed coils in the Roberts boilers were replaced by new coils. A new shaft and wheel were put in, replacing a worn shaft and broken wheel, the engine was overhauled and reset, and an iron shoe put on to protect the keel, a portion of which had to be removed. The boat was calked and repainted throughout.

Very respectfully, your obedient servant,

DONALD ALLEN, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

T 3.

IMPROVEMENT OF CHANNEL IN WEST GALVESTON BAY, TEXAS.

West Galveston Bay is an expanse of water between Galveston Island and the mainland and extends from Galveston Bay to the west end of Oyster Bay. It is connected with the Gulf of Mexico by San Luis Pass,

having a depth of 7 to 8 feet, and with Brazos River by the Galveston and Brazos Canal, in which the depth has been dredged to 7 feet. The natural channel through the bay was crooked and narrow and its depth varied from 2.5 to 5 feet.

A channel having a navigable depth of 5 feet was dredged through the bay in 1859 by the State of Texas; it had, however, shoaled to its original depth at the time a survey was made in 1891.

The project adopted for this improvement consisted in straightening and widening the channel to 200 feet and in deepening it so that 3.5 feet of water was available for vessels from the railroad bridges crossing the bay near Galveston to San Luis Pass. A channel 100 feet wide and 3 feet deep was also to be dredged along Christmas Point in Oyster Bay, and beacons were to be erected in the bay so as to properly define the channel.

This improvement was commenced January 19, 1893, and the first work consisted in dredging a channel 100 feet wide and 3.5 feet deep across Deer Islands Reef, but owing to the insufficient plant of the contractor this was not completed until July 31, 1894.

The plant was then transferred to Karonkaway Reef, the next place that dredging was required, where work was commenced August 17 and continued until October 22, 1894, when operations were suspended and the contract closed as the contractor failed to make satisfactory progress.

The amount of material removed at Karonkaway was 3,150 cubic yards, the channel being 26 feet wide and 4 feet deep.

The act of August 17, 1894, having appropriated a further sum of $5,000 for this work, a contract was entered into on December 8, 1894, with Charles Clarke & Co., of Galveston, Tex., for continuing it.

Operations were commenced on March 22, 1895, and consisted in completing the channel across Karonkaway Reef, this having been accomplished on June 26, 1895. This channel is 100 feet wide and 4 feet deep, and the amount of material removed under the present contract was 7,697 cubic yards.

The details of the season's work are shown in the report of Mr. Donald Allen, assistant engineer, which is forwarded herewith.

Amount expended to June 30, 1894	$6,067.53
Amount expended during present fiscal year	7,341.33
Total amount expended to June 30, 1895	13,408.86

Abstract of appropriations made by Congress for improving channel in West Galveston Bay, Texas.

By act of—	
July 13, 1892	$15,000
August 17, 1894	5,000
Total	20,000

The sum of $9,000 can be profitably expended during the fiscal year ending June 30, 1897, in completing the work.

The work is located in the collection district of Galveston, Tex. The nearest light-houses are at Half-Moon Reef and Redfish Bar, in Galveston Bay, and at Bolivar and Fort Point at entrance to Galveston Bay. There are life-saving stations at Fort Point and San Luis Pass.

Money statement.

July 1, 1894, balance unexpended		$8,932.47
Amount appropriated by act of August 17, 1894		5,000.00
		13,932.47
June 30, 1895, amount expended during fiscal year		7,341.33
July 1, 1895, balance unexpended		6,591.14
July 1, 1895, outstanding liabilities	$1,348.91	
July 1, 1895, amount covered by uncompleted contracts	4,287.63	
		5,636.54
July 1, 1895, balance available		954.60
Amount (estimated) required for completion of existing project		9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		9,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March, 3, 1893.

Abstract of proposals for dredging channel in West Galveston Bay, Texas, received in response to advertisement dated October 27, 1894, and approved November 27, 1894, at Galveston, Tex., by Maj. A. M. Miller, Corps of Engineers.

No.	Name and address of bidder.	Dredging 15,000 cubic yards, more or less, per cubic yard.	Amount.
		Cents.	
1	Charles Clarke and Robert P. Clarke, Galveston, Tex.*	60	$9,000
2	Branch T. Masterson, Galveston, Tex	60	9,000

Has best available plant; acceptance recommended.

REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1895.

MAJOR: I have the honor to submit the following report of operations for the improvement of channel in West Galveston Bay, Texas, for the fiscal year ending June 30, 1895:

DREDGING.

Mr. Branch T. Masterson, of Galveston, Tex., under his contract of October 7, 1892, continued dredging in West Bay, completing the channel through the reefs in the vicinity of Deer Islands, and dredging one cut 26 feet wide through Karonkaway Reef, when the work was suspended October 22, 1894, on account of the very unsatisfactory progress being made by the contractor.

The channel south of Deer Islands, between Beacons C, E, and F, was completed July 31, 1894. It is 5,080 feet long, 100 feet wide, and 3.5 feet deep at mean low tide. Material dredged in making same, 2,486 cubic yards.

The total length of channel completed and amount of material dredged, under this contract, near Deer Islands, was:

LENGTH OF CHANNEL.

[During the fiscal year 1894.]

North of Deer Islands, from Beacon A to B, 2,700 linear feet, 160 feet wide.
Between Deer Islands, from Beacon B to C, 2,035 linear feet, 100 feet wide.

[During the fiscal year 1895.]

South of Deer Islands, from Beacons C to E to F, 5,080 linear feet, 100 feet wide.
Total length of channel, 9,815 linear feet.

Amount of material dredged.

	Cubic yards.
Fiscal year 1894, between Beacons A and B	7,069
Fiscal year 1894, between Beacons B and C	1,258
Fiscal year 1895, between Beacons C, E, and F	2,486
Total material	10,813

The completion of the dredged channel through the reefs near Deer Islands gives a channel 100 feet wide, with a minimum depth of 3.5 feet at mean low tide, between the railway bridges and Karonkaway Reef.

On August 17, 1894, dredging was commenced at Karonkaway Reef by Branch T. Masterson, and on October 22, 1894, one cut, 2,126 feet long, 26 feet wide, and 3.5 feet deep at mean low tide through the reef, having been completed, the work was suspended for the reasons above-noted.

The total amount of material dredged by Branch T. Masterson in making the cut was 3,150 cubic yards.

A contract with Charles Clarke & Co., of Galveston, Tex., was entered into December 8, 1894, to dredge a channel 100 feet wide and 3.5 feet deep at mean low tide, at Shell, Karonkaway, and other reefs, and at Christmas Point. Dredging was resumed at Karonkaway Reef under this contract by Charles Clarke & Co. on March 22, 1895, at the point on the second cut, where the work was stopped October 22, 1894, and the channel through the reef, 100 feet wide and 3.5 feet deep at mean low tide, was completed June 26, 1895.

The dredged channel is 2,163 feet long.

Total amount of material dredged at Karonkaway Reef.

	Cubic yards.
Under contract of B. T. Masterson	3,150
Under contract of Charles Clarke & Co	7,687
Total	10,847

BEACONS.

Fourteen permanent beacons, defining both edges of the channel dredged through the reefs in the vicinity of Deer Islands were erected in October 1894, located as follows:

Two of them, erected on three piles each, are located opposite Beacons A and D, the north and south ends of the channel.

Two of them, erected on three piles each, are located opposite Beacons B and C, marking the points where the direction of the channel changes.

The remaining ten, erected on one pile each, are located between the large beacons above noted as ranges, six being on the island side and four located on the mainland side of the channel.

The piles are protected from the ravages of the teredo by a 6-inch cast-iron pipe, penetrating the ground not less than 3 feet, and rising above the water 3 feet at mean low tide. All are surmounted by a signal pole and slatted ball 4 feet in diameter, which stands 24 feet above the water in the four large beacons and 9 feet above the water in the ten small beacons.

Very respectfully, your obedient servant,

DONALD ALLEN, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF WEST GALVESTON BAY, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1895.

Vessels navigating the bay, 51 (5 steam vessels, 6 barges, and 40 sailing vessels); length, 20 to 141 feet; draft, 3 to 5 feet; tonnage, 3 to 240 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.
Cotton (10,000 bales)	2,500	$300,000
General merchandise	6,000	290,000
Total	8,500	590,000

Decrease since last year, 1,510 tons.

Comparative statement of commercial statistics of West Galveston Bay, Texas, for fiscal years 1893 to 1895.

Year.	Vessels using bay.	Maximum length.	Maximum draft.	Maximum tonnage.	Freight transported.	Total value.
	No.	*Feet.*	*Feet.*	*Tons.*	*Tons.*	
1893	87	141	5	240	4,897	$622,477
1894	51	141	5	240	10,010	711,500
1895	51	141	5	240	8,500	590,000

T 4.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

Trinity River empties, through several mouths or passes, into Galveston Bay near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably, the one generally used by vessels of late years being the Middle Pass. The depth in this pass is 9 feet or more, and in the river above 16 feet of water is found. Opposite each mouth is a bar, the depth on that of the Middle Pass being 3 feet 6 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches, and in order to accommodate them there should be a channel from 5½ to 6 feet deep.

The project for this improvement contemplates the erection of two parallel jetties at the mouth of the Middle Pass, placed about 275 feet apart and extending 7,750 feet into Galveston Bay, also in closing the other passes by submerged dams.

Previous to the adoption of this project a channel had been dredged and redredged across the bar, and 4,575 feet of east and west jetty had been constructed. Owing to suspension of operations and natural causes this channel, though not obliterated, had shoaled considerably, and of the revetment only 2,100 feet remained in good condition.

Subsequent appropriations were principally applied to extending the west jetty, and at the close of the last fiscal year the length of this jetty was 7,359 feet, it being then practically complete. Of the east jetty 300 feet was still in good condition. In order to afford some immediate benefit to navigation, a channel 100 feet wide and 5 feet deep at mean low tide was dredged over the bar.

The act of August 17, 1894, provided, in making an appropriation for this stream, that a survey of the river from Magnolia to the city of Dallas should be made.

It was recommended that so much of the appropriation as might be necessary be applied to the survey of that portion of the river and that a project be submitted for the expenditure of whatever balance might remain unexpended when the survey had been completed.

This recommendation having been approved a survey party was organized and the survey was commenced on October 23, 1894, at the city of Dallas, and was completed to Magnolia on January 12, 1895. The field notes have been platted and maps prepared.

No other work was done during the fiscal year.

A special agent was employed during the year to keep a record of the commerce and tonnage of the river. Statistics compiled from his report are herewith:

Amount expended to June 30, 1894	$65,184.76
Amount expended during fiscal year	3,732.50
Total expended to June 30, 1895	68,917.26

Abstract of appropriations made by Congress for improving Trinity River, Texas.

By act of—		By act of—	
June 18, 1878	$10,000	September 19, 1890	$10,000
March 3, 1879	2,500	July 13, 1892	10,000
June 14, 1880	4,000	August 17, 1894	5,000
March 3, 1881	10,000		
August 2, 1882	8,000	Total	72,000
August 11, 1888	12,500		

The sum of $20,500 can be profitably expended during the fiscal year ending June 30, 1897, in completing the work.

The work is located in the collection district of Galveston. The nearest lighthouse is at Redfish Bar.

Money statement.

July 1, 1894, balance unexpended	$1,815.24
Amount appropriated by act of August 17, 1894	5,000.00
	6,815.24
June 30, 1895, amount expended during fiscal year	3,732.50
July 1, 1895, balance unexpended	3,082.74
July 1, 1895, outstanding liabilities	172.50
July 1, 1895, balance available	2,910.24
Amount (estimated) required for completion of existing project	20,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	20,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1895.

Vessels using the river, 36 (33 sailing vessels, 2 barges, and 1 steamer); length on deck, 30 to 101 feet; draft, 2.5 to 5 feet; tonnage, 4 to 80 tons; trips made during the year, 1,072; total tonnage, 12,659 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton	79	$7,875	$316
Lumber	8,747	26,337	8,111
General merchandise	1,032	22,285	2,583
Total	9,858	56,497	11,010

Increase since last fiscal year, 2,176 tons.

Comparative statement of commercial statistics of Trinity River, Texas, for fiscal years 1888 to 1895.

Year.	Vessels using river.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Number.	*Feet.*	*Feet.*	*Tons.*	*Number.*	*Tons.*
1888	32	65	4.7	32	1,217	15,958
1889	36	65	4.5	32	1,330	16,737
1890	33	80	5.5	80	1,221	16,887
1891	30	80	5.5	80	1,115	15,733
1892	30	120	5.6	150	1,100	13,994
1893	32	150	5.6	150	1,115	15,641
1894	31	130	5	90	893	11,732
1895	36	101	5	80	1,072	12,659

Transported.

Year.	Cotton.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1888	226	11,863	855	12,944	$88,704	$17,027
1889	148	10,872	1,159	12,179	75,902	17,276
1890	102	10,906	719	11,727	46,347	14,249
1891	38	9,364	552	9,954	47,034	13,582
1892	37	8,753	794	9,584	61,810	13,049
1893	54	8,933	319	9,306	52,907	11,697
1894	214	7,050	418	7,682	68,272	9,000
1895	79	8,747	1,032	9,858	56,497	11,010

T 5.

IMPROVEMENT OF CEDAR BAYOU, TEXAS.

Cedar Bayou discharges into the northwest corner of Galveston Bay at a point about 1½ miles from the mouth of San Jacinto River, and distant about 28½ miles from Galveston. The general width near its mouth is 250 feet, and the ruling depth over the bar at its mouth was 3 feet at mean low tide, while inside a depth of 7 feet existed.

The approved project for this improvement consists in deepening the channel over the bar by dredging, so as to afford a depth of 5 feet at mean low tide, the width of the cut to be about 100 feet, the cut to be protected by brush and stone walls or jetties, rising to a height of about 2½ feet above mean low tide. The total length of these jetties, which were to extend across the bar to a depth of 5 feet in Galveston Bay, was about 5,000 feet. The estimated cost of the work, as revised in 1893, was $38,650.

At the close of the last fiscal year the condition of the work was as follows:

The north jetty was completed for a distance of 1,413 feet, and the south jetty for a distance of 2,888 feet; 1,371 feet of this latter requires raising about 1½ feet in order to complete it.

A channel, 2,830 feet long, 90 feet wide, and 5 feet deep at mean low tide, had also been dredged across the bar between the jetties.

Owing to the fact that no funds were available for this work, operations were suspended during the entire year. It was also impossible, for the same reason, to employ anyone to collect the commercial statistics of this stream for the present fiscal year.

Amount expended to June 30, 1895, $32,150.

Abstract of appropriations made by Congress for improving Cedar Bayou, Texas.

By act of—	
September 19, 1890	$18,150.00
July 13, 1892	14,000.00
Total	32,150.00

The sum of $6,500 can be profitably expended during the fiscal year ending June 30, 1897, in extending the jetties about 1,000 feet, which will complete the project.

The work is located in the collection district of Galveston. The nearest lighthouse is at Redfish Bar.

Money statement.

Amount (estimated) required for completion of existing project	$6,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	6,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Comparative statement of commercial statistics of Cedar Bayou, Texas, for fiscal years 1891 to 1894.

Year.	Vessels using bayou.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Number.	*Feet.*	*Feet.*	*Tons.*	*Number.*	*Tons.*
1891	18	60	3.5	96	.....	.....
1892	16	65	4.5	96	1,080	26,940
1893	15	80	4.5	135	996	20,777
1894	23	110	5	135	912	22,884

Transported.

Year.	Brick.	Cotton.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1891	17,500	50	1,700	19,250	$108,250	$18,612
1892	15,000	50	4,992	20,042	128,250	18,113
1893	15,920	75	4,975	20,970	139,020	16,286
1894	24,000	50	7,960	32,010	140,840	17,560

T 6.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Buffalo Bayou is a tide-water stream, emptying into San Jacinto River at Lynchburg, about 25 miles below Houston and about 8 miles above the junction of the San Jacinto with Galveston Bay. White Oak and Simms bayous are tributaries, the former entering at Houston and the latter at a point about 11 miles below.

A survey of the bayou, with a view to its improvement, was made in 1871, and a subsequent examination between White Oak and Simms bayous was made in 1880. The estimated cost of obtaining a channel 100 feet wide and 12 feet deep in this stream, as stated in the report on the examination, was $385,299.75.

The object of the improvement is to secure for Buffalo Bayou a channel having the same dimensions (100 feet wide and 12 feet deep) as the one contemplated for Galveston Bay, the aim being to admit seagoing ships to Houston. These dimensions of channel exist naturally in Buffalo Bayou below Simms Bayou and in the San Jacinto River, though it is reported that a small bar exists in San Jacinto River near Morgan Canal.

Morgan Canal is the name given to a channel excavated by the Buffalo Bayou Ship Channel Company through Morgan Point, a peninsula at the mouth of San Jacinto River. In Galveston Bay, in prolongation of the canal, is Morgan Cut, also executed by the same company, connecting it with the ship channel dredged in the bay by the United States. The canal and cut now belong to the United States.

It is between White Oak and Simms bayous that improvement of Buffalo Bayou is almost entirely needed. The banks here are high and generally stable, though occasionally subject to landslides. The surface width is generally greater than 100 feet, though there are some exceptions to this rule. The depth in the middle of the channel is usually 9 feet or more at ordinary tide, but there are occasional shoals upon which as little as 5 or 6 feet is found, and during northers the water surface is sometimes lowered several feet. At some points navigation is obstructed by the sharpness of the bends. It is endangered

also by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

The commerce of the bayou is important. It is mostly carried on by means of barges towed by tugs. The draft of the latter is 7 feet or less, that of the former, when full loaded, about 5 feet.

Even if but partial improvement of the channel be made with the sums appropriated, so as to secure 9 or 10 feet of water at mean low tide, the resulting benefit will be not only immediate, but great, and this benefit will be increased by easement of bends and removal of snags, trees, etc. When a 12-foot depth is maintained throughout from Bolivar Channel to Morgan Cut and Canal, and through the latter to San Jacinto River, the depth of Buffalo Bayou can be correspondingly increased as appropriations are made.

A new supply of sunken logs is found annually in Buffalo Bayou and considerable shoaling from surface wash also occurs.

The first appropriation for the improvement of this stream was made in 1881, and subsequent appropriations have been added from time to time. The money has been applied to dredging, easing of bends, and in removal of stumps, logs, and overhanging trees. This work has been of great benefit to the navigation of the stream, enabling boats drawing 8 feet of water to reach Clinton without difficulty, and Houston during most of the year.

Practically no work was done during the fiscal year. A contract was entered into on December 18, 1894, with the Rittenhouse Moore Dredging Company, of Mobile, Ala., for continuing this work. After numerous delays the contractors attempted to commence dredging on May 13, 1895, but the plant proved to be totally insufficient for the purpose. Other plant was procured, and work was finally begun on June 20, 1895. The amount of dredging accomplished from then until June 30 was 125 cubic yards.

The trade of the bayou is practically carried on by the Houston Direct Navigation Company with tugs and barges, but many small vessels visit it. To ascertain the extent of the trade a special agent was employed to keep a daily record of the commerce and tonnage of the bayou. Large shipments of cotton are made from Houston to Galveston by water, to be loaded on seagoing vessels at the latter place. The number of bales shipped down the bayou during the present fiscal year was 514,021.

Amount expended to include June 30, 1894	$193,139.49
Amount expended during present fiscal year	1,502.29
Total amount expended to June 30, 1895	194,641.78

It is estimated that the sum of $50,000 can be profitably expended during the fiscal year ending June 30, 1897, in continuing the improvement by again going over the ground, more or less, where dredging has been done; in widening the waterway where the surface width is less than 100 feet and where the cost of widening is not excessive, and where the banks will bear such widening without danger of sliding; in deepening the channel where its depth is less than 10 feet; in easing the bends, and in removal of logs, stumps, etc.

Abstract of appropriations made by Congress for improving Buffalo Bayou, Texas.

By act of—		By act of—	
March 3, 1881	$25,000	September 19, 1890	$25,000
August 2, 1882	50,000	July 13, 1892	25,000
July 2, 1884	25,000	August 17, 1894	15,000
August 5, 1886	18,750		
August 11, 1888	25,000	Total	208,750

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay.

Money statement.

July 1, 1894, balance unexpended		$610.51
Amount appropriated by act of August 17, 1894		15,000.00
		15,610.51
June 30, 1895, amount expended during fiscal year		1,502.29
July 1, 1895, balance unexpended		14,108.22
July 1, 1895, outstanding liabilities	$290.00	
July 1, 1895, amount covered by uncompleted contracts	13,500.00	
		13,790.00
July 1, 1895, balance available		318.22
Amount (estimated) required for completion of existing project		176,549.75
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals for dredging in Buffalo Bayou, Texas, received in response to advertisement dated October 27, 1894, and opened November 27, 1894, at Galveston, Tex., by Maj. A. M. Miller, Corps of Engineers.

No.	Name and address of bidder.	Dredging 30,000 cubic yards.		Logs pulled, 1,500 cubic feet.		Trees felled, 15,000 cubic feet.		Stumps and wrecks per hour.	Amount, not including wrecks and stumps.
		Per cubic yard.	Amount.	Per cubic foot.	Amount.	Per cubic foot.	Amount.		
1	Charles F. Walker, Houston, Tex	Cents. 40	$12,000.00	Cents. 8	$120.00	Cents. 6½	$975.00	$15.00	$13,095.00
2	Rittenhouse Moore Dredging Co., Mobile, Ala.*	30	9,000.00	6	90.00	5	750.00	13.50	9,840.00
3	Henry Camors, New Orleans, La	38	11,400.00	6	90.00	7	1,050.00	12.00	12,540.00

*Lowest bid; acceptance recommended.

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1895.

Vessels using the bayou, 112 (14 steam vessels, 35 barges, and 63 sailing vessels); length, 20 to 162 feet; draft, 2.5 to 6.5 feet; tonnage, 2.5 to 358 tons; trips made during the year, 3,525; total tonnage, 389,574.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton and products	141,101	$15,997,675	$234,564
Wood and coal	9,972	114,789	7,617
Lumber and shingles	452	5,431	813
General merchandise	8,943	125,901	16,932
Total	160,468	16,243,796	259,926

Increase since last year, 52,403 tons.

Comparative statement of commercial statistics of Buffalo Bayou, Texas, for fiscal years 1888 to 1895.

Year.	Vessels using bayou.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Number.	*Feet.*	*Feet.*	*Tons.*	*Number.*	*Tons.*
1888	89	173	8	254	920	.....
1889	64	173	7	254	735	.....
1890	68	173	7	254	617	.....
1891	68	162	6	358	2,274	295,869
1892	114	162	6.5	358	3,345	398,452
1893	112	162	8	413	2,587	303,764
1894	100	162	6.5	358	3,000	307,819
1895	112	162	6.5	358	3,525	389,574

Transported.

Year.	Cotton and products.	Wood and coal.	Lumber and shingles.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	36,651	4,320	2,765	6,105	49,841	$5,132,323	$94,960
1889	53,855	3,456	1,221	2,018	60,550	7,617,380	98,794
1890	86,051	2,970	512	6,701	96,234	13,880,766	154,715
1891	94,017	9,810	622	3,639	108,088	16,243,395	156,906
1892	105,989	15,595	1,538	9,112	132,179	13,790,650	206,719
1893	80,596	8,343	1,001	16,706	106,646	12,836,894	175,759
1894	76,766	11,419	841	19,039	108,065	12,262,667	169,995
1895	141,101	9,972	452	8,943	160,468	16,243,796	259,926

T 7.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The project for the improvement of this harbor, adopted in 1881, contemplated the construction of two jetties extending out into the Gulf of Mexico, the object being to fix the channel over the bar at the entrance to the harbor and to deepen it. These two jetties were to be built about 1,500 feet apart, and one, the south or Brazos Island Jetty, to be 3,630 feet long, and the other, the north or Padre Island Jetty, to be 2,940 feet long. Work was suspended on this improvement in October, 1884, the Brazos Island Jetty having been completed, and the subject of the improvement referred to The Board of Engineers for report. A new survey was called for, which was made in 1887, and reported on September 29, 1887. The report showed that the south or Brazos Island Jetty, completed in 1884, had practically disappeared. The cost of an improvement to consist of two parallel jetties placed about 1,100 feet apart was estimated at $1,130,000, and it was stated that at least $600,000 should be available before work was commenced. Adding previous expenditures of $188,590.23 to this estimate makes the revised cost of the improvement $1,318,590.23.

Nothing has been done on this work since the survey made in 1887, the amount of money available having been too small to warrant commencing it.

A special agent was employed during the year to keep a record of all incoming and outgoing trade. Commercial statistics compiled from this record are herewith.

The conclusion that not less than $600,000 should be available before undertaking further work is here concurred in, though it is not asserted

that the amount of commerce to be benefited justifies such an expenditure at this time. There remains, in round numbers, $543,000 as the sum that should be appropriated for the fiscal year ending June 30, 1897, in case Congress orders the improvement continued.

Original estimated cost of the work as revised in 1888	$1,318,590.23
Aggregate amount appropriated to June 30, 1894	247,500.00
Amount expended to July 1, 1894	189,949.00
Amount expended during fiscal year	30.00
Total expended to July 1, 1895	189,979.00

In addition, $6,000 was appropriated in 1878, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest lighthouse is the Brazos Santiago Light on Padre Island.

Abstract of appropriations made by Congress for improving harbor at Brazos Santiago, Tex.

By act of—		By act of—	
June 14, 1880	$25,000	August 5, 1886	$37,500
March 3, 1881	75,000	August 11, 1888	25,000
August 2, 1882	60,000		
July 5, 1884	25,000	Total	247,500

Money statement.

July 1, 1894, balance unexpended	$57,551.00
June 30, 1895, amount expended during fiscal year	30.00
July 1, 1895, balance unexpended	57,521.00
July 1, 1895, outstanding liabilities	15.00
July 1, 1895, balance available	57,506.00
Amount (estimated) required for completion of existing project	1,071,090.23
Amount that can be profitably expended in fiscal year ending June 30, 1897	543,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEX., FOR THE FISCAL YEAR ENDING JUNE 30, 1895.

Vessels using the harbor, 19 (4 steamers and 15 sailing vessels); length on deck, 26 to 220 feet; draft, 2 feet to 8 feet 6 inches; tonnage, 5 to 718 tons; trips made during the year, 110; total tonnage, 40,474 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Wool and hides	2,278	$113,400	$19,389
Lumber	992	14,780	5,403
General merchandise	7,932	420,186	90,395
Total	11,202	548,366	115,187

Decrease since last year, 2,707 tons.

Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for the fiscal years, 1888 to 1895.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Number.	*Feet.*	*Feet.*	*Tons.*	*Number.*	*Tons.*
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536
1892	15	220	9.4	717	127	48,724
1893	26	220	9.4	717	158	44,927
1894	18	220	9.4	718	144	51,127
1895	19	220	8.6	718	110	40,474

Transported.

Year.	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	.....	2,925	2,324	9,867	15,166	$737,432	$83,541
1889	130	3,080	3,188	10,885	17,283	820,315	78,140
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,132
1891	.....	3,218	2,434	15,992	21,644	1,061,082	160,215
1892	.....	3,092	1,865	12,538	17,495	846,946	165,852
1893	.....	2,469	2,243	12,711	17,423	811,289	159,723
1894	.....	2,612	2,521	8,826	13,959	611,368	129,660
1895	.....	2,278	992	7,932	11,202	548,366	115,187

T 8.

PRELIMINARY EXAMINATION OF COLORADO RIVER FROM THE MOUTH TO THE CITY OF WHARTON, TEXAS.

[Printed in House Ex. Doc. No. 141, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1894.

SIR: I have the honor to submit the accompanying copy of report of December 12, 1894, by Maj. A. M. Miller, Corps of Engineers, of the results of a preliminary examination of Colorado River from the mouth to the city of Wharton, Tex., made to comply with requirements of the river and harbor act of August 17, 1894.

Major Miller is of opinion that the river from the mouth to Wharton is not worthy of improvement by the General Government, and this opinion is concurred in by the division engineer, Col. C. B. Comstock, Corps of Engineers, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 12, 1894.

GENERAL: In compliance with instructions contained in letter from the office of the Chief of Engineers, United States Army, dated Washington, D. C., August 20, 1894, I have the honor to report as follows

on the preliminary examination of the "Colorado River from the mouth to the city of Wharton, Tex."

The examination was made under direction from this office in October, 1894, by Mr. S. M. Wilcox, assistant engineer.

The Colorado River from Wharton to its mouth, where it empties into Matagorda Bay, has a southerly course, with a length of about 60 miles, flowing through Wharton and Matagorda counties.

This portion of the river may be divided into three sections: First, the section from Wharton to the head of raft, a distance of about 30 miles; second, the raft, which covers a distance of about 15 or 20 miles; and third, the portion from the lower end of raft to the mouth, a distance of about 12 miles.

The first section of the river, from Wharton to the raft, flows between bluff banks, heavily timbered for a distance back from river varying from one-half to 1½ miles; the height of banks decrease from 30 feet at Wharton, where two bridges cross the river, to about 3 feet at head of raft; the range between high and low water is about 15 feet, the bridges at Wharton have a clearance of about 15 feet at high water.

This portion of the river varies in width at low water from 75 to 100 feet, and has several sharp bends. There are several sand bars, shifting with each rise, with a depth of about 3 feet over them at low water. The depth between bars is about 5 feet to a point about 10 miles above the raft, where a depth of 4 feet is found, and from this point the water deepens to over 30 feet at head of raft, the raft forming a lake or pool about 10 miles in length. These depths were obtained by soundings taken at low water. There are a few snags in this portion of the river, but many overhanging trees.

At Red Bluff, opposite Bay City, which is situated about 2 miles above the head of raft, the banks are about 8 feet high. It is stated that fifteen years ago these banks were 20 or 30 feet high, thus showing an apparent backing up of the water by the raft of at least 12 feet. There is a slight current at low water in this portion of the river of from 1 to 1½ miles per hour until the head of pool above raft is met, where the river becomes a lake or pool 10 or 12 miles long and about 300 feet wide, with several small outlets, principally on the west side.

The second or raft section of the river is choked and filled by drift of every description. The big raft, 300 feet wide and 5 miles long, is between 25 and 50 feet in depth, and is practically solid, although water percolates through it at low stages. The raft has large trees 18 to 24 inches in diameter growing on its surface, and is said to be building upstream at the rate of 5,000 feet a year. The rafts form a chain, becoming less compact and solid as the lower portion is reached.

The present raft started to form in 1860. In 1853 a canal was dug around the then existing raft, and the present raft now occupies that channel. The total length of the chain of rafts is 15 to 20 miles.

The third section of river, that from the foot of the chain of rafts to the mouth, is generally over 10 feet in depth. The banks are from 6 to 10 feet high, the timber thinning out as the mouth is reached. At the mouth, where the river empties into Matagorda Bay, there is a mud bar about one-half mile wide, with about 18 inches depth on crest at mean tide. Scattered over this bar are a number of snags and drift. The bay is shallow for some distance, having a depth of from 2½ to 3 feet about 1 mile from the town of Matagorda, situated at the mouth of the river.

The average fall of the river from Wharton to the mouth is about two-tenths foot to the mile.

The Colorado River rises from 10 to 18 feet above ordinary low water during floods, bringing down large masses of drift; frequently trees 120 feet long are seen. These floods, meeting the obstruction of the raft, spread out over a territory about 12 miles square to a depth of from 2 to 10 feet. Last year the water backed up to within 15 miles of Wharton. The lower portion of Matagorda County is not now subject to overflow, but formerly suffered when the head of raft was nearer that locality. The bottom lands are idle, though fertile.

COMMERCIAL STATISTICS.

It has been very difficult to obtain any authentic information in regard to the commercial statistics of the Colorado River. Previous to 1853 there seems to have been no navigation. Between 1853 and 1858 a steamer made two trips up the river as far as Austin. Since that time there has been no attempt at navigation on the river.

The town of Wharton, where the examination of the river began, is a place of from 1,000 to 1,200 inhabitants. The Southern Pacific Railroad here crosses the river and is the only available means of transportation except teaming. The town is the county seat of Wharton County and ships 8,000 or 10,000 bales of cotton, and some cattle and hides, annually.

Bay City, 30 miles south of Wharton, on the Colorado, is the county seat of Matagorda County. It is at present of no commercial importance, as it is only 3 or 4 months of age. It has no railroad communication.

Matagorda, situated at the mouth of the river, has about 500 inhabitants and does little or no business except to furnish supplies to the outlying ranches. There is some cotton raised and shipped here, but the principal industry in this vicinity is cattle raising. There is no railroad here.

The country tributary to the Colorado River is generally grazing land.

From the above statistics, which are all that are available, it will be seen that if the river were rendered navigable there would be very small interests benefited.

In order to render the Colorado River navigable the snags should be destroyed, overhanging trees cut, and the raft removed. This last would be a very costly operation, and the expenditure is not justified by the needs of commerce.

If the raft were removed the level of low water would be much lowered, and it is doubtful if low-water navigation would be improved.

Turning the channel of the river by canals or other means would not be justified, in my opinion, on account of the great cost.

An examination of this river, with the view of removing raft at its mouth, was made in December, 1890, and the report thereon is found in the Report of the Chief of Engineers for 1891, page 1939 et seq.

There is forwarded herewith the report of Mr. Wilcox, assistant engineer, by whom the present examination was made, to which attention is invited.

On account of the great cost, I am of the opinion that the Colorado River, from the mouth to the city of Wharton, Tex., is not worthy of improvement and that no survey is necessary.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, December 17, 1894.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Major Miller, I do not think the improvement worthy of being made by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. S. M. WILCOX, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 30, 1894.

MAJOR: I have the honor to report as follows on the preliminary examination of the Colorado River, from Wharton to the mouth.

In accordance with instructions contained in letter of October 15, 1894, I left Galveston, October 16, arriving in Wharton, October 17. Here I met Messrs. J. G. Barbee, W. F. Linn, and J. G. Rieves, and with their assistance endeavored to hire or buy a skiff to go down the river in. Failing to secure boat, I left Wharton on the morning of the 18th, in team, accompanied by Mr. J. G. Rieves, for Bay City, near head of the big raft, at a distance of 30 miles from Wharton, reaching Bay City same evening. Here I met Mr. G. M. Magill, of the Bay City Company, who had come down river from Wharton some ten days before my arrival. From my talk with him and information obtained from old inhabitants along the river, from the people of Wharton and Matagorda and my own observation, I am enabled to report as follows:

The river.—The Colorado River is separated by nature into three parts. The first, a distance of about 30 miles between Wharton and head of raft; the second, a distance of between 15 and 20 miles, covered by raft, and third, from lower end of raft to mouth, a distance of about 12 miles.

First section.—From Wharton to head of raft the river runs between bluff banks heavily timbered for a distance back, ranging from one-half to 1¼ miles and sometimes more, gradually decreasing in height from about 30 feet, where two bridges cross at Wharton, to about 3 feet near head of raft. Range between high and low water is from 15 to 18 feet, giving bridges at Wharton a clearance of about 15 feet above high water.

There are several sharp bends, but as width of river is from 75 to 100 feet they would cause but little trouble. There are several sand bars, shifting with each rise, but at present holding about 3 feet with river at low stage; general depth 5 feet until within 10 miles of raft, where water deepens from 4 to no bottom at 30 feet.

There are not many snags, but many overhanging trees.

At Red Bluff, opposite Bay City, the banks, I am told, were 20 or 30 feet high some fifteen years ago; they now are only about 8 feet above the surface of stream.

There is a slight current of about 1 or 1¼ miles per hour until within 10 or 12 miles of raft, where the river becomes a lake 10 or 12 miles long and about 300 feet wide, with several small outlets, principally on the west side.

Second section.—From the head of rafts, about 3 miles below Elliotts post-office, to the lower end of last raft the river is filled with all kinds of drift. The big raft, 300 feet wide, 5 miles long, and between 25 and 50 feet thick, is practically solid, although water passes through it. This raft has raised the surface of the river over 20 feet, forming lake spoken of above. The rafts are formed of all kinds of drift, and are said to be building upstream at the rate of 5,000 feet per year. Large trees, 18 to 24 inches in diameter, are growing on the rafts. The rafts form a chain, becoming less solid as we proceed down river.

The present raft started to form about 1860. In 1853 a canal was dug around the raft then in river, and present raft occupies that channel.

There are said to be 6 or 8 rafts in the river, covering a distance of between 15 and 20 miles.

Third section.—From end of last raft to bar at present mouth of river, a distance of between 10 and 15 miles, the river is deep, generally over 10 feet, banks 6 to 10 feet high, timber thinning out as mouth is reached. At mouth, where river empties into Matagorda Bay, there is a mud bar about one-half mile wide, with about 18 inches on crest at ordinary tide; scattered over this flat are a number of large snags, making navigation at night rather dangerous for such boats as can come into the river at

Matagorda. The bay is very shallow for some distance, having from 2½ to 3 feet about 1 mile in front of town.

The average fall of river from Wharton to mouth is about two-tenths of a foot per mile of river.

Floods.—The Colorado River rises from 10 to 18 feet above ordinary low water, bringing down large masses of drift; frequently trees 120 feet long are seen. The flood water striking raft spreads out over adjoining lands, covering a territory of about 12 miles square to a depth of from 2 to 10 feet. Last year high water was within 15 miles of Wharton, and I am informed caused considerable uneasiness at that place. The lower portion of Matagorda County does not suffer at present, but did years ago when raft was nearer to them.

The bottom lands are idle, and, although very fertile, a number of families have moved away, fearing to remain near the river; about 40 families are now living along both sides of river, between Wharton and Matagorda.

Commercial.—Previous to 1853 there seems to have been no navigation of the Colorado. Between 1853 and 1858 a steamer made two trips up the river as far as Austin; since then there has been no attempt at navigating the river.

The town of Wharton, of about 1,000 or 1,200 inhabitants, is the only town of importance on this portion of the river. It is the county seat of Wharton County, and ships 8,000 or 10,000 bales of cotton, some cattle and hides.

The Southern Pacific is the only railroad.

Bay City, 30 miles south of Wharton, present county seat of Matagorda County, is at present of no commercial importance, as it is only about three or four months of age. No railroad.

Matagorda, the former county seat of Matagorda County, is of about 500 inhabitants and does little or no business outside of furnishing necessaries to the outlying ranches.

There is some cotton raised and shipped, but the principal industry is cattle raising.

There is no railroad.

The country tributary to the Colorado River is for the most part grazing lands.

For further information, I respectfully call your attention to the attached letters from the citizens of Wharton and Matagorda and Port Lavaca.

Improvements.—It would be a very expensive undertaking to remove rafts in the Colorado River; a canal could be excavated around them, turning channel of river.

* * * * * * *

I am much indebted to Messrs. J. G. Barbee, W. F. Linn, and J. G. Rieves, of Wharton; Mr. G. M. Magill, of Bay City; Mr. Wordsworth, of Matagorda, and Judge Mahan, of Port Lavaca, for information and facilities furnished me during my inspection.

Very respectfully, your obedient servant,

S. M. WILCOX, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

NOTE.—The citizens of Wharton claim that opening the Colorado River to navigation would reduce their freight rates from 30 to 50 per cent, and would open the lands adjacent and tributary to the river to settlement, thus increasing the value of the country and output many-fold. Letters promised from Wharton and Port Lavaca were not furnished.

S. M. W.

LETTER OF MR. D. P. MOORE, COUNTY TREASURER.

MATAGORDA, TEX., *October 26, 1894.*

DEAR SIR: Replying to your inquiries in regard to country affected by raft in Colorado River, will briefly state the following facts: The raft that now impedes navigation and completely dams up the river is composed of a solid mass of drift, occupying 3 or 4 miles of the river bed. Having originally formed at or near the mouth of the river, it is now some 19 miles in an air line from its mouth, and is constantly forming and building upward during freshets, and thereby submerging new country yearly, doing a great deal of damage to farmers, in some instances, where they are located 3 or 4 miles from the channel of the river, submerging thousands of acres of fine lands.

This river is one of the largest in the State, and conveys a large volume of water at low stage, and if freed from raft or opened around through some chain of lakes that flank the river it would make a fine navigable waterway for considerable distance.

The counties of Wharton and Matagorda, through which the river runs and so disastrously affects by its overflows, are probably the most fertile counties in the State

and are now rapidly settling up with a thrifty class of farmers. Besides this, the county of Matagorda is building a new county-seat town within 2 miles of the river, at a point about 3 miles above the raft, and will expend $40,000 or $50,000 in county buildings. For these and other reasons that I can not briefly state it seems that this stream is worthy of an actual survey, and this I trust the Department will grant.

Respectfully,

D. P. MOORE, *County Treasurer.*

Mr. S. M. WILCOX, *Galveston, Tex.*

T 9.

PRELIMINARY EXAMINATION OF GUADALUPE RIVER, TEXAS, FROM ITS MOUTH TO THE CITY OF CUERO.

[Printed in House Ex. Doc. No. 155, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 21, 1894.

SIR: I have the honor to submit the accompanying copy of report of December 13, 1894, by Maj. A. M. Miller, Corps of Engineers, of the results of a preliminary examination of Guadalupe River from its mouth to the city of Cuero, Tex., made to comply with requirements of the river and harbor act of August 17, 1894.

It is the opinion of Major Miller that the river from its mouth to Cuero is not worthy of improvement by the General Government, and this opinion is concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 13, 1894.

GENERAL: In compliance with instructions contained in letter from the office of the Chief of Engineers, United States Army, dated Washington, D. C., August 20, 1894, I have the honor to make the following report on the examination of the "Guadalupe River from its mouth to the city of Cuero, Tex.:"

An examination of the Guadalupe River from its mouth to Cuero was made in October, 1894, by Mr. S. M. Wilcox, assistant engineer, whose report is forwarded herewith and to which attention is invited.

Previous examinations of this river were made in 1874, under the direction of Capt. C. W. Howell, Corps of Engineers (see Report Chief of Engineers for 1875, p. 924 et seq.), and in 1889, under the direction of Maj. O. H. Ernst, Corps of Engineers (see Report Chief of Engineers for 1889, p. 1577 et seq.).

The Guadalupe River from Cuero to its mouth flows in a southerly direction, slightly inclining to the eastward. It flows through Dewitt, Victoria, and forms part of the boundary between Refugio and Calhoun counties. Its length from Cuero to the mouth, where it empties into San Antonio Bay, is about 62 miles. It has a velocity at low water of

from 1 to 1½ miles per hour. Between Cuero and Victoria, a distance of about 26 miles, there is a fall of 6 feet. Three feet of this fall occurs at a point about halfway between those places, at what is said to be the remains of an old dam in the river, over which there is about 10 inches of water at low stage. From Victoria to the mouth the fall is about two-tenths of a foot to the mile. The bed of the river is alternately clay and gravel. The bluffs vary in height from 25 to 40 feet until near the mouth, where the banks are but 3 or 4 feet high, reaching back 3 or 4 miles to the bluff of the prairie. The banks show no signs of gravel except at Victoria. Above Cuero rock crops out.

The river is crossed by five bridges—three iron highway bridges at Cuero and one highway and one railroad bridge at Victoria—all having their lower chords about 50 feet above low water. The range between high and low water is from 15 to 25 feet; the depth, except at the old dam above mentioned, varies between Cuero and Victoria from 2½ to 15 feet, and from 3 to 15 feet between Victoria and the mouth. There are a few deep (marked) bends, the longest being just below Victoria. The bar at the mouth of the river, where it empties into San Antonio Bay, is very soft, and has a depth of 3 feet over it.

OBSTRUCTIONS.

Between Cuero and Victoria there are about ten gravel shoals, with from 2½ to 3 feet of water over them, and one small fall of 2 to 3 feet, said to be the remains of an old dam, which is about halfway between Cuero and Victoria. There are few snags, but many overhanging trees, in this portion of the river.

From Victoria to Kempners Bluff, a distance of about 25 miles, the river is full of snags for about 8 or 9 miles, and several small rafts are met with. These rafts are about 75 feet long, 50 feet wide, and 10 feet deep. For the next 10 miles below the river is wider and freer from snags, being about 100 feet in width, the depth from 4 to 10 feet. At the head of the big raft, about 18 miles below Victoria, a cut has been made across the neck of the bend 3,000 feet in length, giving a clear river for about 3 miles. The rafts are of recent formation. From the foot of these rafts the only obstructions are snags and overhanging trees until rafts near the mouth of the river are reached; around these latter a channel has been cut, giving 6 feet depth, with a width of 30 feet.

NAVIGATION.

Previous to the war there were five steamers navigating this river between Indianola and Victoria. No information could be obtained relative to navigation above Victoria. There are no crafts navigating the river at present. It is stated that the river was clear before the war, but was closed by obstructions, by orders from General Magruder, to prevent gunboats from running up the river; the present rafts were started in this manner. The boats navigating the river before the war carried cotton, hay, cattle, hides, wood, etc.

COMMERCIAL STATISTICS.

Cuero, the county seat of Dewitt County, situated about 60 miles from the mouth of the river, is a town of about 8,000 inhabitants, and ships about 16,000 bales of cotton, 10,000 head of cattle, hides, etc. The railways here are the Southern Pacific and the San Antonio and Aransas Pass. The latter, I am informed, is controlled by the former.

Victoria, the county seat of Victoria County, about 26 miles below Cuero, has about 10,000 inhabitants, and ships 8,000 to 10,000 bales of cotton and about 15,000 head of cattle, hides, etc. The only railroad is the Southern Pacific. For information concerning Victoria see letter of Mr. J. M. Brownson.

Between Cuero and Victoria the country is farmed, but below Victoria it is given up to grazing.

From the above facts it would appear that by clearing out the river a navigation of 3 feet at low water could be obtained. This would undoubtedly be valuable, and might induce or create a commerce on the river and also by competition decrease freight rates, but such a commerce would require improvements at the mouth of the river. At present there are no facilities for such a trade, as the entrances to Aransas Pass and Matagorda Bay are not in a condition to invite remunerative navigation.

In view of the above facts, I am of the opinion that the Guadalupe River, from its mouth to Cuero, Tex., is not worthy of improvement, and that a survey is not necessary.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, December 19, 1894.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Major Miller, I do not think this river worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. S. M. WILCOX, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 30, 1894.

MAJOR: I have the honor to report as follows on the preliminary examination of the Guadalupe River from Cuero to the mouth:

In accordance with orders of October 15, 1894, I left Galveston October 16, and after examining Colorado River proceeded from Port Lavaca, on the morning of October 22, 1894, and arrived at mouth of Guadalupe River; hired boatman and boat and proceeded up river for some distance. On this trip I met Capt. Amos Jordan, who navigated the river previous to 1858; from him I obtained a large amount of valuable information as to past and present conditions of the Guadalupe River. From mouth I worked upstream, finishing at Cuero. In this report I commence at Cuero and proceed downstream.

The river.—The Guadalupe River from Cuero to mouth flows with a current of from 1 to 1½ miles per hour at low stages, between bluff banks ranging from 25 to 40 feet in height until near mouth, where banks are but 3 or 4 feet high, reaching back 3 or 4 miles to the bluffs of the prairies; banks quite heavily timbered from water's edge back from river for a distance of from 500 feet to 1½ miles, being mostly willow and cottonwood. Approximate fall is about 6 feet in 26 miles between Cuero and Victoria, there being a single fall of about 3 feet about halfway between these places;

from Victoria to mouth the natural fall is about two-tenths foot to the mile of river; bed of river is alternately clay and gravel, banks show no signs of gravel, except at Victoria and above Cuero, where rocks crop out.

The river is crossed by five bridges, three iron highway bridges at Cuero, with about 30 feet between lower chord and low-water mark; at Victoria one railway bridge (Southern Pacific Railway), and one highway bridge at about same height as bridge at Cuero. The range between high and low water is between 15 and 25 feet. Depths range between 2½ and 15 feet between Cuero and Victoria, and from 3 feet to no bottom at 15 for remainder of distance.

There are few bad bends, the worst being just below Victoria. Width of river from 75 to 150 feet, with numerous snags, rafts, etc. The river empties into San Antonio Bay; channel depth about 6 feet; bar at mouth has 3 feet; very soft. About 18 miles, by river, below Victoria there is a cut-off 3,000 feet long, 100 feet wide, and 6 to 10 feet deep, with swift current. This turns river around big raft, and was excavated by citizens of Victoria.

Obstructions.—From Cuero to Victoria there are about 10 gravel shoals, with from 2½ to 3 feet on them, and one small fall of between 2 and 3 feet, said to be remains of old dam. This is about halfway between Cuero and Victoria. There are few snags and many overhanging trees on this portion.

From Victoria to Kempners Bluff, a distance of about 25 miles by river, the river is full of snags, and for the first 8 or 9 miles several small rafts, partly obstructing river, are encountered. These rafts are about 75 feet long by 50 feet wide by 10 feet deep. For next 10 miles to big raft river is wider and clearer of snags, being about 100 feet or more in width. Depth, 4 to no bottom at 10 feet; no bad bars, and two bad bends, the first bad bend 3 miles below Victoria, about 900 feet across and 1½ miles around. The second, 6 miles below Victoria, 150 feet across and 1½ miles around.

At head of big raft, some 18 miles below Victoria, the citizens have changed channel of river by excavating canal through neck of bend 3,000 feet in length, giving river clear channel for about 3 miles, when another raft is met, filling river from bank to bank. This raft is of recent formation and could be easily removed. From here to within 3 or 5 miles of mouth of river no more rafts are reported, but about same conditions exist as to snags and overhanging trees as in upper river.

The rafts at mouth of river are small, being three in number, and about 75 feet by 200 feet by 15 feet in dimension. They are about one-half mile apart, and last one about 1½ miles above mouth. There is a channel cut through them near west bank, being about 30 feet wide and 6 feet deep. Although this portion of river is full of sunken logs, nowhere did I get less than 6 feet depth except at mouth, where I got 3 feet on bar, soft mud.

Navigation.—Previous to civil war there were five steamers plying on river between Indianola and Victoria. I could obtain no information relative to navigation above Victoria.

Capt. Amos Jordan, a former pilot, informed me that river was clear, and was choked up by orders of General Magruder, to prevent gunboats ascending river; the present raft started this way. These statements are corroborated by citizens of Victoria. These boats carried cotton, hay, cattle, hides, wood, etc.

Commercial.—Cuero, county seat of Dewitt County, is of about 8,000 inhabitants, and ships about 16,000 bales of cotton, about 10,000 head of cattle, with hides, etc. The Southern Pacific Railway is the only railroad.

Victoria, county seat of Victoria County, about 10,000 inhabitants, ships 8,000 or 10,000 bales of cotton, about 15,000 head of cattle, with hides, etc. The Southern Pacific Railway is the only road.

Between Cuero and Victoria the county is given up to farming, but below Victoria the county is used for grazing.

* * * * * * *

I am indebted to the following gentlemen for information and assistance during my inspection: Messrs. Linn & Dunlop, H. G. Austin, and W. A. Woods, of Victoria; O. Bushnell & Co., H. Runge & Co., and Mr. D. Heaton, of Cuero.

For further information as to the present and prospective commerce of the Guadalupe River, I respectfully call your attention to the attached letters from the citizens of Cuero and Victoria.

Very respectfully, your obedient servant,

S. M. WILCOX, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

NOTE.—Letters promised from Cuero were not furnished.

LETTER FROM MR. J. M. BROWNSON, PRESIDENT FIRST NATIONAL BANK OF VICTORIA, TEX.

VICTORIA, TEX., *November 17, 1894.*

DEAR SIR: I must undertake to give you the information you asked Mr. Dunlap for. I have urged him and Mr. Linn to reply to your letter, but they were too closely occupied with the election and its results. I am fearful it is too late for your purpose, but I will give you such information as I have been able to gather.

The annual shipment of freight by rail from Victoria station, exclusive of cotton and cattle	pounds..	12,000,000
Cotton, about	bales..	8,000
Car loads of horses, cattle, mules, and hogs		140
Freight received	pounds..	27,218,000
Products of county not exported:		
Corn	bushels..	375,000
Potatoes, sweet	do....	50,000
Potatoes, Irish	do....	10,000
Pease	do....	1,000
Hay, cultivated and wild	tons..	15,000
Sugar cane, made into sirup, about	barrels..	500
Sorghum cane	tons..	3,000

Our county is rapidly settling up now with farmers, a large majority of whom are from the counties of Travis and Fayette. We have gained quite 200 families within the last two years, so that we may reasonably expect a large and continuous increase in production of all the articles named. Lower rates of freight to Galveston, Houston, and New Orleans would immediately increase the production of hay and corn especially, and many other things that we export would, of course, be largely increased. We have made this year a very heavy crop of cotton and hay, but our corn crop was not so good on account of failure of rains at the proper time.

Should you desire further information and will propound questions to me I will give prompt and reliable answers.

Very respectfully,

J. M. BROWNSON.

Mr. S. M. WILCOX,
United States Assistant Engineer, Galveston, Tex.

T 10.

PRELIMINARY EXAMINATION OF THE BAR AND HARBOR AT BRAZOS SANTIAGO, TEX.

[Printed in House Ex. Doc. No. 140, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 18, 1894.

SIR: The river and harbor act of August 17, 1894, provides for a preliminary examination of the bar and harbor at Brazos Santiago, Tex., and the duty of making this examination was assigned to Maj. A. M. Miller, Corps of Engineers, and I have the honor to submit the accompanying copy of his report of December 11, 1894, on the subject.

Major Miller is of opinion that this harbor at present is not worthy of improvement by the General Government. This opinion of Major Miller is concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 11, 1894.

GENERAL: In compliance with instructions contained in letter from office of the Chief of Engineers, United States Army, dated Washington, D. C., August 20, 1894, I have to report as follows on the preliminary examination of "bar and harbor at Brazos Santiago, Tex."

The information in possession of this office is sufficient without recourse to an actual examination of the bar and harbor at Brazos Santiago, Tex.

An examination of this locality was made by Lieut. H. M. Adams, Corps of Engineers, in February, 1871. From this examination it was ascertained that the depth of water over the bar at the entrance to the harbor was 7 feet at high water, with a shifting channel. The depth in the harbor was at that time 27 feet, and the estimated cost of improvement at that time, by the construction of one jetty, was $775,000.

The report states that the necessities of commerce at the time did not seem to call for such an expenditure. The commercial statistics showed in 1869 the arrivals and departures to be 102 vessels; tonnage, 42,110; and in 1870, arrivals and departures, 86; tonnage, 40,176.

A survey of this locality was made in 1881, under the direction of Maj. S. M. Mansfield, Corps of Engineers, who submitted a project for deepening the channel across the bar and the maintenance of a suitable harbor inside the pass by constructing two jetties at mouth of entrance extending to the 12-foot curve, and of a dam from Point Isabel to Brazos Santiago. The south jetty was to be 3,630 feet and the north jetty 2,940 feet long. The estimated cost of this improvement was $678,084.50. This project was submitted to the Board of Engineers in 1881, who approved of it, so far as the application of available funds would permit, to construction of south jetty.

The construction of south jetty was commenced in 1882 and was continued until 1884, when operations were suspended for lack of funds. During that time 3,955 feet of jetty was constructed.

The subject of this improvement was referred to a Board of Engineers for report on December 8, 1885. The Board called for certain information which required a resurvey to be made. This survey was made from June to August, 1887.

The report on the survey showed that the south jetty, constructed from 1882 to 1884, had practically disappeared.

The Board of Engineers recommended in their report that no further work of improvement be at present attempted at the localities under their consideration, one of which was the harbor at Brazos Santiago, Tex. (See Report Chief of Engineers for 1888, p. 1299 et seq.)

An exhaustive report was made on the improvement of this harbor in 1887 by Maj. O. H. Ernst, Corps of Engineers. (See Report Chief of Engineers for 1888, p. 1322 et seq.)

Amount appropriated for this work	$247,500
Amount expended to date	189,949
Balance of appropriation unexpended	57,551

As will be observed from the accompanying table of commercial statistics, the commerce of the harbor is gradually diminishing and the number of vessels using the harbor is becoming less.

From the above report and the accompanying statistics it would appear that the present needs of commerce do not justify so large an

expenditure as would be required to permanently improve the bar and harbor at Brazos Santiago, Tex.

I am of the opinion that this harbor at present is not worthy of improvement, and that no further survey is necessary.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, December 15, 1894.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated herein, and in view of the limited area of deep water inside the bar, I do not think this harbor at present worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for fiscal years 1869 to 1894.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Number.	*Feet.*	*Feet.*	*Tons.*	*Number.*	*Tons.*
1869	.....	.....	.....	.....	102	42,111
1870	.....	.....	.....	.....	86	40,177
1885	.....	.....	.....	.....	96	.....
1886	.....	.....	.....	.....	65	.....
1887	11	.....	.....	.....	98	.....
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536
1892	15	220	9.4	717	127	48,724
1893	26	220	9.4	717	158	44,927
1894	18	220	9.4	718	144	51,127

Transported.

Year.	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1869	.....	.....	.....	.....	.....	.....	.....
1870	.....	.....	.....	.....	.....	$4,293,457	.....
1875 to 1880	.....	.....	.....	.....	.....	4,000,000 to 5,000,000	.....
1881	.....	.....	.....	.....	.....	4,851,630	.....
1888	.....	2,925	2,324	9,867	15,166	737,482	$83,541
1889	130	3,080	3,188	10,885	17,283	820,315	78,140
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,132
1891	.....	3,218	2,434	15,992	21,644	1,061,082	160,215
1892	.....	3,092	1,865	12,538	17,495	846,946	165,852
1893	.....	2,469	2,243	12,711	17,423	811,289	159,723
1894	.....	2,612	2,521	8,826	13,959	611,368	129,660

T 11.

PRELIMINARY EXAMINATION OF BRAZOS RIVER, TEXAS, FROM THE CITY OF WACO TO THE TOWN OF RICHMOND.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 15, 1895.

GENERAL: In accordance with instructions contained in letter dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., August 20, 1894, I have the honor to make the following report on the preliminary examination of "Brazos River, Texas, from the city of Waco to the town of Richmond."

This examination was made under my direction by Mr. S. W. Campbell, assistant engineer. He left Waco on January 4, and completed the examination to Richmond on February 5, 1895.

A survey of the Brazos River, from Waco to its mouth, was made in 1875 (see Report of the Chief of Engineers for 1875, p. 929 et seq.), and a report on a preliminary examination from its mouth to Waco was made in 1891 (see Report of the Chief of Engineers for 1892, p. 555 et seq.).

From reference to these reports and information gathered from the present examination the condition of the stream and its adaptability to improvement is as follows:

The Brazos River, Texas, from Waco to Richmond, a distance of 328 miles, flows in a southeasterly direction between high banks and over a much obstructed bed. At the time of the examination the river was at a very low stage, so much so that in many places it would not float a skiff.

The obstructions consist of rock ledges and sand and gravel shoals, and railroad and other bridges without draws.

No.	Nature of obstructions.	Distance from Waco.	Remarks.
		Miles.	
1	Suspension bridge	0	Span, 470 feet; elevation, 40 feet above river bed.
2	Cotton Belt Rwy. Bridge	0	Iron truss; spans, 125 feet; elevation, 35 feet above river bed.
3	Missouri, Kansas and Texas Rwy. Bridge.	0	Iron truss; spans, 150 feet; elevation, 35 feet above river bed.
4	Rock Dam	30½	Gravel shoal ending in rock ledge; fall, 2 feet.
5	Falls of the Brazos	43½	Rock shoal with rapids; total fall, 6½ feet
6	Upper Blue Shoal	51	Gravel shoal, followed by bed of limestone 300 yards long.
7	Lower Blue Shoal	58½	Similar to above; one-half mile long.
8	Curleys Shoal	72	River blocked by loose rock and bowlders 8 to 10 feet high.
9	Calvert or Cannon Ball Shoal	75	Length, one-half mile, and obstructed by bowlders.
10	Wagon bridge	.....	1 span, 175 feet; elevation, 30 feet above river bed.
11	Herndens Shoals	77	2 miles long; river bed entirely obstructed by loose rock and bowlders.
12	Pat Sullivan Shoals	86½	Rock shoal with 3 separate falls of 1 foot each.
13	Wagon bridge	87	3 spans of 125 feet each; elevation, 30 feet above river bed.
14	International and Great Northern Rwy. Bridge.	.....	1 span of 150 feet and one of 75 feet; elevation, 40 feet above river bed.
15	Neblins Shoal	112	One-fourth mile long, with fall of 1 foot.
16	Williams Shoal	.....	Rock shoals and rapids; fall, 2 feet.
17	Munsons Shoal	121	Rock shoals and rapids; total fall, 4 feet.
18	Wagon bridge	.....	1 span of 160 feet and 2 of 112 feet; elevation, 30 feet above river bed.
19	Gulf, Colorado and Santa Fe Rwy. Bridge.	.....	Iron truss; 2 spans 150 feet each; center pier on sand bar in river; elevation, 30 feet.
20	Hidalgo Falls	167	Rock ledge with bowlders; fall, 4½ feet.
21	Wagon bridge	.....	1 span of 100 feet and 2 of 75 feet; elevation, 30 feet.
22	Gates Ferry	195½	Rock ledge.
23	Houston and Texas Central Rwy. Bridge.	.....	Iron truss; 3 spans 150 feet each; elevation, 30 feet.

No.	Nature of obstructions.	Distance from Waco.	Remarks.
		Miles.	
24	Cochrans Shoals	226¾	Rock and gravel shoal; fall, 3½ feet.
25	San Filipe Shoal	266¼	Rock shoal.
26	Rock shoal	270	Rock ledge, with fall of 2½ feet.
27	Texas Western Rwy. Bridge	272	1 span of 150 feet, and approaches; elevation, 30 feet.
28	Missouri, Kansas and Texas Rwy. Bridge.	274	2 spans 150 feet each and 1 of 75 feet; elevation, 30 feet.
29	San Antonio and Aransas Pass Rwy. Bridge.	.....	2 spans 112 feet each; elevation, 40 feet.
30	Ferris Shoal and Fall	324	Rock shoals and rapids; fall, 3 feet.

NOTE.—Depth of water on shoals at time examination was made varied from 2 to 8 inches.

Between the above obstructions numerous small shoals and gravel bars as well as snags were found.

The fluctuations of this portion of the river between high and low water is about 15 feet, but no data is accessible to determine the duration of high or low water.

There being no towns along the river from Waco to Richmond, it was impossible to obtain a statement of the commercial statistics of that portion of the river. The principal products are cotton and corn. The Commercial Club, of Waco, was having the statistics compiled and promised to forward the statement to this office and it will be forwarded as soon as received.

The only method of improving this stream to admit of low-water navigation would be by means of locks and dams. The fall from Waco to Richmond is over 300 feet and this method of improvement would require an expenditure of probably $3,000,000 to $4,000,000. Even if such expensive works were contemplated it is very doubtful if a sufficient water supply could be obtained to render the locks available at low water.

In view of the great cost, in my opinion this stream is not worthy of improvement.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Lieut. Col. H. M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, February, 28, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons given by the district officer I am of opinion that the Brazos River, from Waco to Richmond, is not worthy of improvement by the United States.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. S. W. CAMPBELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 9, 1895.

MAJOR: In accordance with your instructions of January 2, 1895, I left Galveston for Waco on the 4th, arriving there that night, and made the trip from Waco down to Richmond in a 14-foot skiff with one man to help me, and accompanied by two men in a boat sent by the Commercial Club, of Waco, to see that I made the trip through. These men were not employed by me, nor were they at any expense to the Government.

The river banks vary from 30 to 50 feet in height, and the bed from 350 to 500 feet in width, with a very large volume of water in it during the wet seasons, but now nearly dry owing to the long drought.

There are no towns on the river between Waco and Richmond, but many farms and plantations, the people living from 1 to 2 miles away from river banks.

The products are cotton and corn, of which a great deal is raised. I could not obtain any statistics in regard to the products, as the owners of these places live in the towns 4 to 10 miles from the river, only negroes living on the farms.

I was very much delayed by the low stage of the river, making it necessary to walk and drag the boat a great deal of the time; also had very bad weather—rain, sleet, and cold nearly all the time, so did not arrive at Richmond until February 5.

The river was found to be at an unusually low stage (said to be the lowest for thirty years). For the first 40 miles the depth of water was not sufficient to float a skiff with two persons in it.

The banks vary from 20 to 50 feet in height and in width the river is 500 feet at Waco, and narrows down to about 300 feet.

At Waco there are three bridges crossing it—a suspension bridge of 470 feet with lower cords 40 feet above bed of river, and the Cotton Belt Railroad and the Missouri, Kansas and Texas Railroad bridges, the spans of which are 125 and 150 feet each, and the lower cords are 35 feet above bed of river.

The obstructions to navigation in the first 40 miles are very slight shoals, with the exception of "Rock Dam," which, at an ordinary stage of the river would not be noted.

Just below "Horse Shoe Bend" the river has cut a new channel through a bend. This is said to have been done in the last four years.

"Rock Dam," 30¼ miles below Waco, commences with a gravel shoal one-fourth mile long; then the river is dammed up by limestone rock and bowlders for 200 feet, with a fall of 2 feet. Between "Rock Dam" and Brazos Bridge, near Marline, is a gravel shoal. There is a sand bar in the river under the bridge. The bridge is two spans of 150 feet each and approaches; elevation, 40 feet above river bed.

Falls of the Brazos, 43½ miles below Waco, is a very serious obstruction. The shoals are of soft limestone for 1 mile, with a ledge extending diagonally across the bed of river and an abrupt fall of 3½ feet; then rapids for one-half mile, with two falls of 1½ feet each, and ending with a sand and gravel bar 500 feet long, 125 feet wide, and 5 feet high. The water flows over this shoal through the crevices in the rock, and is only 2 to 6 inches deep at the present stage of river.

Upper Blue Shoal, 51 miles below Waco, commences with a gravel shoal 300 yards long; then the river flows over a bed of soft limestone with pieces of sandstone scattered about it, the water flowing through many little crevices. There are snags in the river between this and Lower Blue Shoals.

Lower Blue Shoal, 58½ miles below Waco, is similar to the above, and is one-half mile long.

Between Lower Blue Shoal and Curleys Shoals there are three gravel shoals and rapids, with snags and drift lodged in many places.

Curleys Shoals, 72 miles below Waco, is a very serious obstruction. The river is blocked up with loose rock and bowlders in many places 8 to 10 feet high, while a narrow channel is obstructed by lime and sandstone bowlders of 5 to 30 tons.

Calvert or Cannon Ball Shoal, 75 miles below Waco, is a half mile long. The river is obstructed by round bowlders of 1 to 5 tons, and just below is a wagon bridge of one span of 175 feet and approaches; elevation 30 feet above river bed.

Hirndens Shoals, 77 miles below Waco, are 2 miles long. The river bed is entirely obstructed by loose rocks, bowlders, and ledges of lime and sandstone; lignite along right bank. A great mass of drift lodged on this shoal; had to have boat carried around this place by a wagon, as it was found to be impossible to take it across. Two and a half miles below this shoal is a dam of logs and rock across the river, said to have been built by a fisherman. Had to cut through the dam with an ax. A slight rock shoal in the river at this place. Between this and Port Sullivan Shoal there are two small rock shoals; rock just to water's surface.

Port Sullivan Shoals, 86½ miles below Waco, is the most serious obstruction of any, beginning with a ledge of limestone across the bed of the river and several

ledges of limestone in its bed. The river is obstructed by large lime and sandstone bowlders for three-fourths of a mile. There are three separate falls of about 1 foot each, ending with a gravel shoal, and a wagon bridge across river of three spans 125 feet each; elevation, 30 feet above bed of river.

Between Port Sullivan and the International and Great Northern Railroad Bridge is a gravel shoal. The bridge has one span of 150 feet and one of 75 feet; elevation 40 feet above the bed of the river.

Between the International and Great Northern Railroad Bridge and Niblins Shoals are two sand and gravel shoals and two slight rock shoals, with rock just to water's surface, also snags in the river.

"Niblins Shoals," 112 miles below Waco, extends for one-fourth of a mile with a fall of about 1 foot. Not noticeable at ordinary state of river.

"Williams Shoals," below Little Brazos River, are rock shoals and rapids with one fall of 1½ feet and one of one-half foot. Snags in the river for 300 yards below.

Munsons Shoal and Rapids, 121 miles below Waco, is 1 mile long, over a bed of soft rock and a great deal of petrifaction along the bed of the river. There is an abrupt fall of 2 feet, and a total fall from beginning to end of shoal of about 4 feet approximately.

Between Munsons Shoal and the Gulf, Colorado and Santa Fe Railroad Bridge (Navasota branch) is a wagon bridge of three spans, one of 160 feet and two of 120 feet each; elevation 30 feet above bed of river. There is a gravel bar in the bed of the river, one gravel shoal, and two small rock shoals, also an island of rock and sand 4½ miles above the Gulf, Colorado and Santa Fe Railroad Bridge, with a good channel on both sides.

The Gulf, Colorado and Santa Fe Railroad Bridge (Navasota branch) crosses the river 1½ miles above Yegua Creek. The bridge is an iron structure of two spans, of 150 feet each. The center pier is on a sand bar in the river. The elevation of the lower chords is 30 feet above the bed of the river. Old piling (false-work piles) obstruct the river. There are a great many snags 300 yards above the bridge and a slight rock and gravel shoal 300 yards below.

Between the Gulf, Colorado and Santa Fe Railroad Bridge and Hidalgo Falls are Hoxies Rocks, a ledge extending three-fourths way across the river bed with snags and drift in river. Eight miles below is a narrow ledge of rock across the bed of the river at the water's surface.

Hidalgo Falls, 167 miles below Waco, is a very serious obstruction, the river flowing over the rocks for 500 yards; there are several ledges of rock and also large bowlders in the bed of the river. An abrupt fall of 2½ feet, then rapids with several falls of one-half to 1 foot each. The bed of the river is 500 feet wide and the water flows through little and crooked channels, and they are obstructed by loose rocks. The fall from beginning to end is 4½ feet approximately.

Between Hidalgo Falls and Gates Ferry, 195¼ miles below Waco, are fifteen slight sand and gravel shoals with snags lodged on many of them. There is also a wagon bridge of three spans, one of 100 feet and two of 75 feet each, the lower chords being 30 feet above bed of river.

At Gates Ferry rock on both banks extend out into river with a narrow channel between.

Between Gates Ferry and Cochrans Shoal the only obstructions are slight gravel shoals and snags in many places.

The Houston and Texas Central Railroad Bridge (Austin branch) is a wood and iron structure of three spans on rock piers; spans are 150 feet each; elevation 30 feet above the bed of river. The river is obstructed by old piling under the bridge; also by snags and drift lodged on a sand bar in the bed of the river.

Cochrans Shoals, 226¾ miles below Waco, is a rock and gravel shoal for 700 feet with a fall of 3½ feet from beginning to end, and has three small islands of rock in river with very narrow channels, obstructed by loose rocks.

Between Cochrans Shoal and San Felipe are eight gravel shoals and one small rock shoal, a narrow ledge across bed at water's surface.

About 5 miles below Cochrans Shoal is a large gravel bar in a bend of the river, forming a narrow channel next to the right bank, which is obstructed by trees falling into the river. Three-fourths of a mile below San Felipe is a rock shoal for one-fourth mile with rocks just to the water's surface.

Three and a half miles below San Felipe a rock shoal extends for three-fourths of a mile, with one fall of 1 foot and one of 1½ feet. The Texas Western Railroad crosses here. The bridge is one span of 150 feet and approaches; elevation 30 feet above bed of river.

One and a half miles below this is the Missouri, Kansas, and Texas Railroad Bridge of two spans of 150 feet each and one of 75 feet; elevation 30 feet above river bed. The river is here obstructed by old piling and a sand bar under the bridge. A gravel shoal just above this bridge.

Between the Missouri, Kansas and Texas and the San Antonio and Aransas Pass Railroad Bridge the only obstructions are small sand bars and gravel bars, with snags and drift lodged on them.

The San Antonio and Aransas Pass Railroad Bridge near Wallis is an iron structure of two spans of 112 feet each and approaches; elevation 40 feet above bed of river. Old piling in the river under the bridge.

At 1, 3¼, 5½, 7, and 7½ miles below the San Antonio and Aransas Pass Railroad Bridge are gravel shoals and snags.

At 10, 11½, 12½, 13, 13½, 15, and 17 miles below the San Antonio and Aransas Pass Railroad Bridge are rock shoals and rapids from 300 feet to 500 yards long each, and with falls from one-half to 1½ feet each.

Ferris Shoals and Falls, about 4 miles above Richmond, is one-half a mile long, with 1½ feet fall in the first 200 feet; then rapids over the rock, and ending with an abrupt fall of 1½ feet. The rock extends along right bank for one-fourth of a mile below. The depth of water over the shoals was only from 2 to 8 inches.

The river, judging from water marks along the banks, has from 2½ to 3 feet more water at ordinary low water and 12 to 15 feet more at ordinary high water than at the present low stage, due to the long drought of six or eight months.

There was no water in the tributaries and no current in the reaches of the river where water was found covering the bed of the river. These reaches are from 1 to 5 miles long with a depth of from 1 to 7 feet of water in them.

METHOD OF IMPROVEMENT.

From only a preliminary examination the length of shoals and the height of falls were only approximately obtained, and it is very difficult to form any estimate as to the cost of improving the river; also from the fact that the river during rises is continually changing its bed alternately by washing away of one bank and depositing large quantities of sand and soil on the other bank, especially in the bends of the river.

All the wagon and railroad bridges will require draws put in them to allow steamboats to pass during ordinary high water.

A great many of the snags will be cut out and carried away by the first big rise, as they are only lodged on sand bars.

The difference in elevation of ordinary low water between Richmond and Waco is 113 feet.

* * * * * * *

I could not obtain any commercial statistics. The Commercial Club of Waco is having them compiled and will forward them to you.

Very respectfully, your obedient servant,

S. W. CAMPBELL, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Agricultural products raised in the twelve counties bordering on the Brazos River, Texas, from Waco to Richmond.

Commodity.	Quantity.	Value.
Cotton.....bales..	281,234	$8,437,020
Cotton-seed products.....	.....	885,288
Grain.....bushels..	7,113,105	3,632,456
Wool.....pounds..	37,311	373,110
Sugar cane and products.....	.....	332,000
Cattle and hogs.....	.....	1,197,247
Farm products.....	.....	675,900
Total value.....	.....	15,533,021

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SURVEY OF BRAZOS RIVER, TEXAS, FROM THE TOWN OF VELASCO TO THE TOWN OF RICHMOND.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 14, 1895.

GENERAL: In accordance with letter dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., September 1, 1894, I have the honor to report as follows on a survey of the "Brazos River, Texas, from the town of Velasco to the town of Richmond":

The party for making the survey was organized at Richmond on November 7, 1894, and the survey was completed to Velasco on November 28, 1894; thus the total distance of 89 miles was completed in twenty-two days. The survey consisted in determining by transit the low-water lines and upper banks of the river and the level of the river surface and banks, cross sections being taken at an average of every mile.

The stage of the river at the time of survey was low—below the average low stage.

The Brazos River, Texas, from Richmond to Velasco flows in a generally southerly direction, the distance between these points being 89 miles. It flows through Fort Bend and Brazoria counties and empties into the Gulf of Mexico about 5 miles below Velasco. Its low-water level is affected by the Gulf tide as far up as Bolivar Landing, about 40 miles above Velasco. The fall of the river at the stage of the survey from Richmond to Bolivar Landing is 43.3 feet—this in a distance of 49 miles; fall from Bolivar Landing to Velasco, a distance of 40 miles, is 2.7 feet.

The towns on the river are as follows:

Richmond, in Fort Bend County, the county seat, is 89 miles above Velasco; has a population of 2,500, and is a distributing point, and ships by rail 5,000 bales of cotton.

Sugar Land, 8 miles south of Richmond and 2 miles from the river, has a large sugar refinery with an output of 5,000,000 pounds per month.

Thompsons, 22.5 miles below Richmond, ships by rail 2,500 bales of cotton.

Bolivar Landing, a small settlement 43 miles below Richmond, has a cotton gin and compress, and ships entirely by river; this gin and compress have just been started.

Columbia, 61 miles below Richmond, has about 1,600 inhabitants; ships 4,500 bales of cotton, and has a gin and compress.

Brazoria, 69.5 miles below Richmond, the county seat of Brazoria County, has 1,200 inhabitants, and ships 3,500 bales of cotton.

Velasco, 89 miles from Richmond, is a new town 5 miles above the mouth of the river; is the headquarters of the Brazos River Channel and Dock Company, which company is said to claim control of the river and to claim right to collect tolls from mouth to some distance above Velasco.

The course of the river is tortuous, with banks varying in height from 47 feet at Richmond to 9 feet at Velasco at time of survey. The obstructions to navigation consist of shoals and snags and a fall of 1.5 feet at Bolivar Landing.

The depth on the shoals at low water varies from 6 inches to 5 feet. The snags are distributed over the whole length of the stream, but are more frequent in the upper portion. The banks are composed of clay,

he bottom of stream below sand and gravel being hard, with hardpan utcropping at the falls near Bolivar Landing.

As usual in streams of this character, the shoals divide it at low water nto a series of pools. There are three bridges crossing the stream—wo at Richmond and one 22.5 miles below. These bridges are iron russes without draws, their lower chords varying in height from 46.3 o 51 feet above low water. The difference between high and low water 37 feet at Richmond and the same at the Gulf, Colorado and Santa e Railroad Bridge, 22.5 miles below that point, leaving a clearance nder this latter bridge of 9 feet at high water.

COMMERCIAL STATISTICS.

The country through which the Brazos River flows is extremely rtile, the crops consisting of cotton, sugar cane, and corn. One of he largest sugar refineries in the country is situated on this stream—he output last year being 40,000,000 pounds, and includes the product om Cuban raw sugar imported for refining. Cattle, horses, and hogs re also raised quite extensively. The average yearly commerce of the iver, exclusive of Velasco, is 6,000 bales of cotton, 30,000 sacks of otton seed, 600 hogsheads of sugar, and 1,200 barrels of molasses. his amount would doubtless be increased were the river improved for avigation.

The navigation of the river is at present carried on by the Columbia ransportation Company, which makes more or less regular trips from alveston, by way of West Galveston Bay and the Galveston and razos Canal as far as Columbia, and when the stage of water permits nd the demand justifies the boats extend their trips farther upstream.

The navigation of the Brazos between Richmond and Velasco could e improved for navigation at good boating stages by the removal of nags and overhanging trees. It is estimated that $10,000 would put his portion of the river in a good navigable condition at ordinary tages, and an annual expenditure of $2,500 would keep it in this ondition.

There are forwarded herewith the report of Mr. S. M. Wilcox, assist-nt engineer, who had charge of the survey. A reference to his report ill furnish detailed information; also six tracings of plat of survey and ngitudinal section showing elevation of bank, bed, and water surface t time of survey.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Lieut. Col. H. M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, March 16, 1895.

Respectfully forwarded to the Chief of Engineers.

There seemed to be some discrepancies in the river profile accompanying this report. After correspondence, I have ascertained "that the profiles of the top of the bank and of the water surface of the lower Brazos River are correct, but that the profile of the bottom, which was

The shoals encountered were hard gravel and sand for the first 22¼ miles; then sand, clay, and some gravel to the fortieth mile; rock or hardpan at the forty-first mile, and hard clay for the remaining distance to the fiftieth mile, from which point no more shoals or bars were found, bottom being soft, overlying a hard floor, probably clay.

These snags are of every kind of timber that grows along the banks—willow, cottonwood, oak, ash, hackberry, elm, and, in river below Bolivar Landing, live oak. These snags occur generally in bunches in bends and in places in middle of straight stretches. Some places—say half a dozen—were noticed where the banks were made up of this drift and silt.

At and near the vicinity of the Devils Elbow, 75¼ miles from Richmond and 6 miles below Brazoria, the river has changed its direction within the last twenty years, and the lake that formerly was at this point is filled to a height of 8 feet above the present stage of river, the river performing this work since 1887, so I am informed. From this point to Buffalo Camp Creek, in the seventy-seventh and a half mile, indications of change of bed are seen, the present river being to the westward of the old bed.

From Buffalo Camp Creek to Velasco, a distance of 11¼ miles, the bank shows signs of caving, and bench marks, stakes, etc., of old surveys are on the point of falling into the river, which were originally set some 50 feet back from bank. The bottom here is soft, but by prodding with sounding pole hard bottom was found beneath the soft carpet, showing that the bottom retains its characteristic hardness.

Timber, etc.—Overhanging trees are very numerous, being about 800 in number. They are caused by the erosion of banks during high water, the number changing with each rise.

The timber line varies in width from a few hundred yards to 3 or 4, (and sometimes more) miles. The varieties represented are as follows: Willows and cottonwood immediately adjacent to the water, with sycamore, oak, hackberry, and ash farther away. Below Bolivar Landing to within 8 or 10 miles of Gulf large quantities of live oak are found, the timber thinning out in the last 6 miles of the survey. Generally it may be stated that the banks are much overgrown with vines and young growth of willows and cottonwood, often necessitating the cutting of a passage before even a man could get through.

Tributary streams are very few, as may be seen by the map, and, excepting Cow Creek, creek above Columbia, and Buffalo Camp Creek, were dry.

These creeks could not be used for getting rid of snags, etc., as they become almost torrents immediately after a rise and during heavy rains.

High water.—The average difference between high and low water is as follows: At Richmond, 37 feet; at Columbia, 30.3 feet; at Brazoria, 25 feet, and at Velasco from 6 to 8¼ feet.

Obstructions.—From Richmond to near the Gulf, Colorado and Santa Fe Railway Bridge, 22¼ miles, the worst part of the river was found—bottom gravel, hard sand, and clay; shoals 33 in number, the largest being 1,600 feet long and full width of river, 300 feet wide, the smallest 150 by 50 feet; depth of water from one-half foot to 2½ feet, and the fall from two-tenths to eight-tenths of a foot. A large number of these shoals are caused by snags lodging on bottom, and change with each rise. The largest one mentioned is permanent. The number of snags counted in this distance was 374, few being under 12 inches in diameter and from 10 to 75 feet in length.

From the Gulf, Colorado and Santa Fe Railway Bridge to Cow Creek, the dividing line between Fort Bend and Brazoria counties, in the fortieth mile, a distance of 18 miles, six shoals, rather small, were found. These were of gravel, clay, and sand, except 175 feet above Cow Creek, where a ledge of rock (hardpan) 6 or 8 feet thick extends across river, having three-tenths foot of water on shoalest part, 5 or 6 feet each side, and a channel on right bank (west bank) holds 6 feet, with a width of 25 feet. There is eight-tenths foot fall in 1 foot here. Length of ledge, 200 feet, butting on gravel bottom on east bank.

Three hundred and sixty-eight snags were counted in this distance, sometimes nearly cutting off channel.

From Cow Creek to falls just above Bolivar Landing, in the forty-eighth mile, 6 shoals were found, all clay, caused by erosion of soft portions of banks, leaving hard parts in the shape of small islands and shoals.

The Falls, as shown on map, is a narrow channel, 120 feet long, 65 feet wide, 5 to 5½ feet deep, fall from eight-tenths to 1½ feet, depending on state of tide in lower river. The whole flow of the Brazos at the present stage passed through this narrow channel. The bottom, sides, and banks are of hard, tough, brownish clay, becoming hard as stone on exposure to heat—viz, drying out—and when wet, slippery as ice.

Number of snags counted, 110, among which many standing trees that have slid from banks.

From Bolivar Landing to Columbia, in the sixty-first mile, a distance of 13 miles, found 1 small clay shoal and 292 snags.

From Columbia to Brazoria, in the sixty-ninth and a half mile, a distance of 8½ miles, clear river, as far as shoals and bars go, and 163 snags. The wreck of an old side-wheel steamer endangers the landing at Brazoria. There is about 1.6 feet on this wreck.

From Brazoria to Velasco, in the eighty-ninth mile, a distance of 20½ miles, deep river and only 47 snags.

From Richmond to Velasco about 250 sunken or submerged snags were found, making total number of snags found 1,604.

The attached table gives number of shoals, length, fall, number of snags, least depth, and greatest depth found for each mile of river.

Bridges.—Three bridges cross the Brazos between Richmond and Velasco—two at Richmond, both iron, one county and one the Galveston, Harrisburg and San Antonio Railway; no drawspans; clearance above water, 51 and 47 feet, respectively. River flows between piers of center spans.

The Gulf, Colorado and Santa Fe Railway Bridge, in the twenty-third mile, iron; no drawspan; clearance above water, 46 feet. There are 24 piles in river under this bridge, in two pile bents, 14 feet center to center, being remains of old railway bridge. River flows between piers of center span. For further information see map.

Cultivation.—In the neighborhood of Richmond cotton and sugar cane are the chief products, the sugar cane being raised almost entirely by and for Messrs. Cunningham & Miller, whose sugar refinery is on Oyster Creek a few miles from Richmond.

From Richmond to Velasco, judging by the plantations that abut on the river, the products are sugar cane, cotton, and corn. In the lower river below Bolivar Landing and along the coast country many cattle are raised, and a good many horses.

Commercial statistics.—For the following statistics I am indebted to the citizens of Richmond, whose report is attached and to which attention is invited; to the citizens of Columbia, Brazoria, and Velasco, and to the Columbia Transportation and Canal Company.

Richmond, county seat of Fort Bend County, is the largest town on the river (surveyed distance), and ships annually about 7,730,000 pounds miscellaneous merchandise freight, with 5,000 bales of cotton, receiving 4,101,600 pounds miscellaneous freight. There are two railroads—the Galveston, Harrisburg and San Antonio Railway passing through the heart of the town and the Gulf, Colorado and Santa Fe Railway, whose station is about 1½ miles south of town center.

Sugar Land, home of the sugar refinery of Messrs. Cunningham & Miller, about 8 miles south of Richmond and 2 miles from the river, has an average output of 5,000,000 pounds of sugar per month, for light months, when working on raw material.

Sugar Land is on the Galveston, Harrisburg and San Antonio Railway, and owns a line of its own that forms a junction with the International and Great Northern Railway.

Thompson's, 1½ miles west of the river and 22½ miles by river below Richmond, is on the Gulf, Colorado and Santa Fe Railway ships about 19,230,000 pounds general freight, 2,500 bales of cotton; receives about 9,205,000 pounds general freight.

From this point until Bolivar Landing is reached no towns are met along the river. The country is more or less under cultivation, as the plantations met with indicate.

Bolivar Landing is a small settlement, has a cotton gin and compress, and ships entirely by river. As the ginning industry has just started, no statement of output could be obtained.

Between Bolivar Landing and Columbia many plantations were passed, a number possessed of sugarhouses. One of the largest, at Eureka, is dismantled.

Columbia, in the sixty-first mile, claims 1,600 inhabitants and ships 4,500 bales of cotton. There is a gin and compress here. The town is situated on the west bank of river, opposite terminal station of the Columbia Tap of the International and Great Northern Railway, which is on east bank. There is a stave factory in this place. Columbia is a disbursing point for surrounding country.

Brazoria, in the sixty-ninth and a half mile, is county seat of Brazoria County, claims 1,200 inhabitants, and claims to ship 3,500 bales of cotton. There are no gins or railroads. It is the headquarters of the Columbia Transportation and Canal Company, and ships its products by river. Like Columbia, it is disbursing point for neighboring country.

Velasco, in the eighty-ninth mile, is a new town, 5 miles above the old town, which has disappeared. It is the home of the Brazos River Channel and Dock Company, which owns present improvements at the mouth of river, and has built wharves and coal elevator, and owns railroad—the Velasco Terminal—that joins the International and Great Northern Railway at Chenango. This company has the power of charging tolls for use of its channel and claims to control the river for some distance above Velasco. Mr. G. W. Angle, of this company, informed me that the company would charge no toll to vessels in the river trade.

For further information relative to improvements, etc., I respectfully call your attention to attached clippings from the Velasco Times of November 23, 1894. (Clippings not forwarded.)

The average commerce of the river, exclusive of Velasco, is about as follows: 6,000 bales of cotton, 30,000 sacks cotton seed, 600 hogsheads sugar, 1,200 barrels molasses; miscellaneous freight, 10,000 tons. These amounts are from Mr. Branch T. Masterson's letter of November 4, 1892, which he informs me is about correct for this time, and a copy of which is attached. This freight is carried by the Columbia Transportation Company, of which Mr. Masterson is a member. (For letter of Mr. Masterson, see Report Chief of Engineers for 1893, p. 1899.)

At present ash logs, obtained near Bolivar Landing, are being rafted down the river, shipped by rail from Velasco to the oar factory at North Galveston.

Navigation.—As to previous navigation, I could gain little information outside of the fact that there had been steamboats plying on the river from mouth as far up as Washington, Washington County. At present the only steamboats in the river trade are the property of the Columbia Transportation Company, which company owns the canal between the Brazos River and West Galveston Bay (i. e. Oyster Bay) and has power of charging tolls for use of canal. There are two regular boats between Columbia and Galveston, and several small steamers that do not go out of river.

I desire to express my indebtedness to my levelman, Mr. W. T. Scudder, for his valuable assistance in prosecution of the survey proper and for intelligent help in collection of information along the river.

Very respectfully, your obedient servant,

S. M. WILCOX, *Assistant Engineer.*

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Table showing number of shoals, length of fall, number of snags, and depth of water, etc.

Miles.	Number of shoals.	Length.	Fall.	Number of snags.	Depth of water.	
					Least depth.	Greatest depth.
		Feet.	*Feet.*		*Feet.*	*Feet.*
1	*1	1,600	.....	40	0.5	5
2	1	.....	0.8	25	2	5
3	2	25	.5	25	2.5	4.5
4	3	150	.2	30	1.5	7
5	4	150	.3	30	2.5	9
6	1	Snags.	.....	15	1	3
7	0	Snags.	.....	20	0.5	10.9
8	0	.....	.....	11	3	4.3
9	1	30	.3	11	1	4.3
10	1	Snags.	.....	11	0.8	9
11	0	.....	.....	11	4	8
12	0	.....	.....	6	12	14
13	3	150	.8	16	9	14
14	2	150	.8	20	2	5
15	0	.....	.....	18	3	5.5
16	2	Snags.	.....	25	3	4
17	5	50	.2	20	3	12
18	2	25	.5	20	0.5	8
19	0	.....	.....	20	3	4
20	1	Snags.	.3	17	3	5
21	2	30	.3	17	2	2.5
22	1	150	.....	17	3	8.5
23	1	100	.3	17	1.5	9
24	†3	50	.....	17	2	7.5
25	0	.....	.....	17	2	10.5
26	0	.....	.....	20	4	12
27	0	.....	.....	19	4	6
28	3	150	.3	23	2	12
29	0	.....	.....	19	2.5	3.5
30	1	125	.3	19	3.5	5
31	1	300	.2	19	3.5	8
32	0	.....	.....	30	4	12
33	0	.....	.....	50	2	4
34	2	150	.8	50	1.8	4
35	0	.....	.....	50	3	4
36	1	100	.5	48	0.9	2.5
37	2	Snags.	.....	.....	1	10
38	0	.....	.....	20	5	12

* Sand, clay, and gravel; bottom hard.
† Clay, sand, and some gravel; bottom hard.

Table showing number of shoals, length of fall, number of snags, etc.—Continued.

Miles.	Number of shoals.	Length.	Fall.	Number of snags.	Depth of water.	
					Least depth.	Greatest depth.
		Feet.	*Feet.*		*Feet.*	*Feet.*
39	1	200	.8	.....	3	6
40	1	30	.8	10	0.9	4
41	2	Snags.	.....	15	2	5
42	0	.....	.....	.....	.....	5
43	1	Snags.	.....	10	.....	10
44	1	25	.8	5	.....	7
45	1	150	.1	.....	3	4
46	0	.....	.....	10	.....	.....
47	0	.....	.....	20	.....	.....
48	0	.....	.....	5	.....	.....
49	*1	120	1.5	25	5	0.13
50	1	75	.....	20	5	7
51	0	.....	.....	25	5	12.5
52	0	.....	.....	30	8	11.5
53	0	.....	.....	22	6	13
54	0	.....	.....	20	2.3	7.2
55	0	.....	.....	20	5	8.3
56	0	.....	.....	20	8	14
57	0	.....	.....	20	9	9.8
58	0	.....	.....	20	8	11
59	0	.....	.....	20	12	12
60	0	.....	.....	20	9.5	9.5
61	0	.....	.....	20	12	21
62	0	.....	.....	20	13	17
63	0	.....	.....	21	13	17
64	0	.....	.....	20	13	17
65	0	.....	.....	39	13	17
66	0	.....	.....	23	13	17
67	0	.....	.....	20	13	17
68	0	.....	.....	20	13	17
69	†0	.....	.....	21	13	18
70	0	.....	.....	10	13	18
71	0	.....	.....	15	13	18
72	0	.....	.....	5	13	18
73	0	.....	.....	5	13	18
74	0	.....	.....	15	13	33
75	0	.....	.....	(‡)	13	33
76	0	.....	.....	.....	13	18
77	0	.....	.....	.....	13	15
78	0	.....	.....	.....	13	15
79	0	.....	.....	.....	13	15
80	0	.....	.....	(§)	13	15
81	0	.....	.....	.....	13	15
82	0	.....	.....	.....	13	15
83	0	.....	.....	.....	13	15
84	0	.....	.....	.....	13	15
85	0	.....	.....	.....	13	15
86	0	.....	.....	.....	13	15
87	0	.....	.....	.....	13	15
88	0	.....	.....	.....	13	15
89	0	.....	.....	.....	13	15

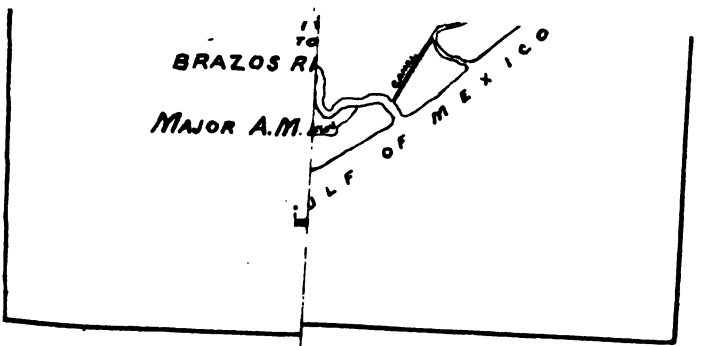
* Falls near Bolivar Landing clay; bottom soft, overlying hard clay.
† Wreck of steamboat Brazoria, 1.6 on top.
‡ Snags very few, not more than one or two to the mile.
§ Some submerged ones, counted when found; say 145 snags in this distance.

NOTE 1.—Cross sections show elevation of water surface and elevation of top of bank. Map gives elevation of water surface at each cross-section.
NOTE 2.—Submerged snags are many, and generally were only found by sounding.

LETTER OF COMMITTEE OF CITIZENS OF FORT BEND COUNTY, TEX.

RICHMOND, *January 1, 1895.*

SIR: The undersigned committee, selected by the citizens of Fort Bend County, Tex., to collect data bearing upon the quantity of exports from, and imports into, said county per annum of wares and merchandise that would naturally be tributary to the Brazos River from Richmond down the river, if said stream were open to navigation, beg leave to report as follows: That for and during the fiscal year of 1893 and 1894 the following quantities of freight were received at and shipped from the rail-



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way stations in said county, the figures being given of pounds of freight, and bales of cotton not estimated and included in giving the pounds of freight shipped, etc.

Name of station.	Shipped	Cotton shipped.	Received.
	Pounds.	*Bales.*	*Pounds.*
Richmond	7,729,474	5,000	4,101,592
Sartartia	3,544,248	1,500	9,039,780
Harlem *	1,500,000	1,200	3,600,000
Sugar Land †	54,000,000	.....	49,022,388
Arcola	4,800,000	.....	.....
Duke	19,226,504	2,500	9,205,560
Thompson	1,026,720	1,500	14,973,300
Orchard	12,560	250	10,065
Rosenberg	40,729,370	500	30,507,950
Fulshear	4,095,255	1,116	3,121,842
Total	136,664,131	13,566	123,584,477

* 77 cars cotton seed. † Crude sugar imported, 40,000,000 pounds.

The quantity of raw sugar was imported by Messrs. Cunningham & Miller during that portion of the year, about eight months, when they are working on the raw material at their factory at Sugar Land, their average per month being about 5,000,000 pounds. This is brought from the West Indies. From all the cattle-shipping points in the county there were shipped over 1,000 car loads of cattle. Thus we have:

Freight shipped from all stations	pounds..	136,664,131
Freight received at all stations	do....	123,584,477
Crude sugar received, not in above	do....	40,000,000
Cotton shipped from all stations	bales..	13,566
Cattle shipped from all stations	cars..	1,000
Cotton seed shipped from Harlem	do....	77

This data is collected and compiled from the most reliable sources, and while it is somewhat large, it is under rather than above what an exact calculation would show.

We respectfully submit the same and trust that it may accompany the report of your work from this place to Velasco.

R. LEE ECHNAN,
C. A. BEASLEY,
Dr. RUGLY PEARESON,
Committee.

S. M. WILCOX,
United States Assistant Engineer.

APPENDIX U.

IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO MISSISSIPPI RIVER; WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Red River above Fulton, Ark.
3. Cypress Bayou, Texas and Louisiana.
4. Ouachita and Black rivers, Arkansas and Louisiana.
5. Bayous D'Arbonne and Corney, Louisiana.
6. Bayou Bartholomew, Louisiana and Arkansas.
7. Bœuf River, Louisiana.
8. Tensas River and Bayou Maçon, Louisiana.
9. Big Black River, Mississippi.
10. Yazoo River, Mississippi.
11. Mouth of Yazoo River and harbor at Vicksburg, Miss.
12. Tchula Lake, Mississippi.
13. Tallahatchee River, Mississippi.
14. Steele and Washington bayous, Mississippi.
15. Big Sunflower River, Mississippi.
16. Big Hatchee River, Tennessee.
17. Water gauges on Mississippi River and its principal tributaries.

EXAMINATIONS.

18. Bayou Dugdemona, Louisiana.
19. Bayou Castor, Louisiana.
20. Little River, Arkansas, from Fulton to White Cliffs.
21. Bœuf River, Arkansas.
22. Bayou Maçon, Arkansas.
23. Yallabusha River, Mississippi.
24. Little River, Louisiana.
25. Bogue Phalia, Mississippi.
26. Bear Creek, Mississippi.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 1, 1895.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

The Red River of the South has its source in the *Llano Estacado*, in the panhandle of northwestern Texas, and flows in a general easterly direction, forming the boundary between Oklahoma and Indian Territories and Arkansas on the north and Texas on the south. It enters the State of Arkansas about 10 miles north of Texarkana, and from Fulton, Ark., to Shreveport, La., its course is changed to a general southerly direction. Below the latter place its course again changes to a general southeasterly direction, and crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The river is about 1,200 miles long. The part included in the project under the title of improving Red River, Louisiana and Arkansas, extends from Fulton, Ark., to the head of Atchafalaya River, Louisiana, a distance of 508.6 miles.

The importance of this great waterway was recognized by Congress as early as 1828, and appropriations for the removal of raft, amounting to more than half a million dollars, were made at intervals between 1828 and 1852. Between 1841 and 1852 no appropriation was made for continuing operations, and a longer period elapsed between 1852 and 1872, during which the results of former work were lost. The lower end of the great raft once was at Natchitoches, if not, as many suppose, still farther downstream, and it extended up the river for more than 100 miles, not in an entire jam, but at intervals, with stretches of clear river between. In 1854 its head had advanced to a point about 50 miles above Shreveport, its length was 13 miles, and it was reported to be forming at the rate of 1½ to 2 miles a year. Between 1855 and 1860 the heavy rates of freight and insurance and disastrous effects of backwater from the raft became so burdensome to the planters that a corporation was chartered under the State laws for the removal of the raft; the assent of Congress was given to the method of improvement by joint resolution of February 21, 1861, and the company authorized to levy tolls for a period of thirty years (Stat. L., vol. 12, p. 250). The company was organized and preparations were made to begin work in the spring of 1861, but the war of the rebellion prevented anything being done.

The appropriations for the early work, from 1828 to 1852, were as follows:

Date of act.	General object of appropriation.	Amount.
May 23, 1828	Improving navigation of Red River through or around the raft in Louisiana and Arkansas	$25,000.00
Mar. 2, 1831	Arrearage due Major Burch for survey of raft of Red River, Louisiana	187.50
July 3, 1832	Improving navigation of Red River, Louisiana and Arkansas, being balance of appropriation of 1828 carried to surplus fund, and the further sum of $20,000	22,628.00
June 28, 1834	Improving navigation of Red River	50,000.00
Mar. 3, 1835	Completing removal of obstructions to navigation of Red River	50,000.00
July 2, 1836	Continuing the removal of obstructions in Red River	40,800.00
	Constructing a boat to prevent a new accumulation of obstructions in Red River within the old limits of the great raft, $15,000, and to work and support same, $15,000	30,000.00
Mar. 3, 1837	Continuing the removal of obstructions in Red River	65,000.00
Apr. 20, 1838	The complete removal of the great raft in Red River	70,000.00
Mar. 3, 1841	Removing the raft of Red River	75,000.00
Mar. 2, 1847	Deficiency of appropriation by act of Apr. 20, 1838, being amount advanced by Daniel T. Witlee and others, through the branch of the Real Estate Bank of Washington, Ark., to Henry M. Shreve, Government agent, for removal of great raft and expended by him for that purpose	7,150.00
Aug. 30, 1852	Removing the raft of Red River	100,000.00
	Aggregate of appropriations, 1828-1852	535,765.50
	Amount expended	532,219.90
	Amount carried to surplus fund	3,545.60

An examination and survey of Red River from its mouth to the head of the raft were ordered by river and harbor act approved March 3, 1871, the reports of which are contained in Reports of the Chief of Engineers for 1872, pages 568–573, and 1873, pages 635–676, under which the present improvement commenced in 1872. The original project contemplated removing the raft above Shreveport, La., and closing Tones Bayou outlet, on the right bank, 19 miles below Shreveport, the gradual enlargement of which diverted a large quantity of water from and seriously affected navigation of the main river below. Subsequently this project was enlarged to include the removal of jams, snags, wrecks, leaning timber, etc.; opening and enlarging the channel through the falls at Alexandria, La.; deepening the channel at shoal places, and closing outlets and constructing and repairing levees to confine the river to the adopted channel, in order to improve and keep navigation open from Fulton, Ark., to the head of the Atchafalaya; also to protect the banks at Alexandria and Shreveport from erosion by the current of the river, and to make a thorough and comprehensive survey from Fulton to the Atchafalaya with a view to the permanent improvement of the river.

The appropriations for the improvement, commenced in 1872, have been as follows:

Date of act.	General object of appropriation.	Amount.
June 10, 1872	Improvement of Tones Bayou, Louisiana	$20,000
	Removing the raft in Red River, Louisiana	150,000
Mar. 3, 1873	....do	80,000
June 23, 1874	....do	50,000
Mar. 3, 1875	....do	20,000
Aug. 14, 1876	Removing the raft in Red River and closing Tones Bayou	35,000
Apr. 10, 1869	Allotment made Aug. 27, 1877, for closing Tones Bayou	4,500
Feb. 7, 1878	Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for the purpose of preserving vessels of United States employed in that work	6,000
June 18, 1878	Removing raft in Red River and closing Tones Bayou	24,000
	Removing snags and other obstructions from Red River	25,000
Mar. 3, 1879	Removing raft in Red River and closing Tones Bayou	15,000
	Removing obstructions from Red River	22,500
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
June 14, 1880	Removing raft in Red River and closing Tones Bayou	25,000
	Removing obstructions from Red River, Louisiana, including construction of snag boat	60,000
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
Mar. 3, 1881	Removing raft in Red River and closing Tones Bayou	10,000
	Removing obstructions from Red River, Louisiana	10,000
Aug. 2, 1882	Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river	75,000
July 5, 1884	Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river	75,000
Aug. 5, 1886	Continuing improvement from Fulton, Ark., to the the Atchafalaya River, Louisiana, including completing the work at Alexandria; $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya and in completing survey of Bayou Pierre, Louisiana	75,000
Aug. 11, 1888	Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria; $5,000, or so much thereof as necessary, to be used upon Cypress Bayou and the lakes between Shreveport, La. and Jefferson, Tex., and $5,000, or so much thereof as necessary, upon Bayou Dorcheat	65,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	35,000
Sept. 19, 1890	Continuing improvement from Fulton, Ark., to the Atchafalaya River; $15,000 to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point, and $5,000 in closing the Sale and Murphy outlet	100,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	28,000
July 13, 1892	Continuing improvement from Fulton, Ark., to the Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey, including the work at Alexandria, the widening of that portion known as Little River, the necessary work at the harbor at	

Date of act.	General object of appropriation.	Amount.
July 13, 1892	Shreveport, the closing of outlets on the west bank of the river above Shreveport, and the removal of the towhead just above Rush Point, Caddo Parish (of which $5,000 may be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.)	$145,000
Aug. 17, 1894	Continuing improvement from Fulton, Ark., to Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey; $15,000, or so much thereof as necessary, to be used in further prosecution of work at Alexandria, and $5,000 for improving Sulphur River, a tributary of Red River	150,000
	Aggregate of appropriations, 1872 to 1895	1,325,000

The amount expended to June 30, 1894, under the project of 1872 and additions was $1,131,705.06 (including outstanding liabilities of $64.75), resulting in great benefit to navigation. In 1872 the great raft had grown to a length of 32 miles (an increase of 19 miles since 1854), extending from Carolina Bluffs, 33 miles above Shreveport, upstream to within 4 miles of the Arkansas and Louisiana boundary line. Judging from photographs taken before and during work upon this obstruction, it would have seemed easier to cut through rock than to open a navigable river through the mass of tangle that grew higher and larger with each flood. The river above the raft was reached only by devious routes, through lakes and overflowed lands on either side, and canals dug by private parties, who exacted heavy tolls, and even these routes were navigable only at stages considerably above low water. A channel was opened through the raft in 1873, and the river as a whole has improved vastly since, both as a navigable stream and as a drain for the great valley through which it flows. The intermittent but frequent attacks of snag boats upon the remains of the raft as they were uncovered by scour has given way for the eroding action of the river, so that it is navigable at far lower stages than was possible even a few years ago. At present at very low stages, say barely a foot above zero at Shreveport, the river is open to boats of 3 feet draft from Fulton to the Atchafalaya. The bottom of the river in the raft region above Shreveport has gone down as much as 15 feet, the low-water line following it to a certain extent, and a similar reduction has been going on below, especially in the stretch known as Little River. The effect has been to lower the general low-water limit, increase the depth, and give a greater carrying power to the whole river.

No work has been done at Tones Bayou since 1882. The bayou has been filling up gradually with drift, and both arms of Old River are closed by sand bars to a height considerably above low water, and the natural closing of the outlet has been aided by the work of snag boats above and below Scopini Cut-off. The section of Little River has widened and scoured, and both sides of the stretch have been leveed, so that the proportion of flood water diverted through the outlet at flood stages is small in comparison with former years. Discharge observations taken in 1872 gave about one-quarter to Little River, the rest escaping through Tones Bayou or over the banks into Bayou Pierre; observations taken in 1893 showed that at that time fully two-thirds of the flood was carried down Little River.

The rock excavation and dam at the Falls of Alexandria were completed in 1885, increasing the period of navigation about two months, and permitting boats to pass the falls the year round. The passage, however, was somewhat difficult at low stages, and dredging operations during the low-water seasons of 1892–93 improved navigation at the

Upper Falls greatly. A crib dam and training wall were built in 1884–85 to protect the bank in front of Alexandria from erosion, and in 1892–93 this work was strengthened and the caving bank below the influence of the dam revetted with stone excavated from the channel at the Upper Falls.

Work for the general improvement of the river from Fulton to the Atchafalaya, by the removal of snags, logs, and wrecks in the channel and clearing the banks, was not begun until 1878, former appropriations having been for removing raft and closing Tones Bayou. Since 1885 operations have consisted chiefly of this class of work, and by persistent efforts of snag boats the river has been kept open, raft prevented from forming, the dangers of navigation reduced to a minimum, and steamboats enabled to make regular trips at low stages. Work of the kind will be necessary for many years, as sunken logs and stumps are scouring loose continually and are a source of great danger to low-water navigation; others, thoroughly water-logged, form bars impassable at lowest stages; and the banks of the upper river for hundreds of miles are covered with a heavy growth of timber, which is caving and sliding continually. During high stages the quantity of drift is enormous, and in the old raft region above Shreveport jams form in a few hours, often acres in extent, and require prompt removal before the water falls. Caving banks leave dangerous shore snags projecting far out into the stream, which should be cut after every rise and fall.

The gradual closing of outlets and building up of the levee system, begun in 1891 and now fully under way, with the speedier delivery of the rainfall, following the development of the valley, denuding it of timber, and reclamation of lands by drainage, must combine to keep the high-water line up until the river shall have scoured a channel large enough to carry it, when a gradual reduction of flood heights may be expected, provided means are taken in time to prevent waste of energy in caving banks and consequent diminishment of slope below a proper working limit. In 1892 a system of levees was begun by cooperation with the State of Louisiana and local levee boards, extending from the hills just above the Arkansas and Louisiana line downstream. During the two years ensuing a large amount of levee work was undertaken, aggregating 4,362,877 cubic yards, costing over $692,000, and consisting of about 74½ miles of new work and 39 miles of enlargement. Less than one-twelfth of this work was built by the United States, and the proportion of its cost was less than 8 per cent.

A thorough survey of high grade was carried from Fulton, Ark., to the Atchafalaya River, connecting with the Mississippi by a line of precise level from Delta to Shreveport, La., which continued downstream to the mouth.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1895.

GENERAL IMPROVEMENT.

June 29, 1894, the gauge at Shreveport read 6.3 feet, falling, and orders were sent M. B. Lydon, master U. S. snag boat *C. W. Howell*, to take that vessel to the head of Atchafalaya River, as soon as the repairs of boiler, etc., were finished, and to work over the river thoroughly back to Shreveport. Supplies were taken aboard and a crew shipped at Shreveport, and on the morning of July 4 the *Howell* left that place and reached Atchafalaya River the night of July 12. July 13 the boat ran to the mouth of Red River to procure fresh water, and commenced

working upstream the same day. On reaching Snaggy Point Bar, 72 miles above the Atchafalaya, July 18, but 4 feet depth was found in the regular channel along the right bank, about 2 feet depth in a chute on the opposite side, with a wide bar between. The chute was closed with brush dams completed July 21, which caused the regular channel to scour and the chute to fill rapidly, and in August steamboat men reported there was better depth at the crossing than ever known at so low a stage. July 21 to September 10 work was carried upstream to Shreveport. Progress was slow on account of low stages of river and the number and size of obstructions encountered. A diver was employed and high explosives used to destroy heavy logs that could not be moved with the snagging apparatus. The policy heretofore pursued of piling heavy timber to stop or prevent caving banks was continued. At White Hall, August 27–28, two boilers, main cylinder, pitmen timbers, wheel, shaft, capstan engine, and hog-chain braces of wreck of steamer *Huntsville* (sunk 1873) were removed, leaving 4 feet depth of channel over remaining portions of wreck. September 11–15 work was continued above Shreveport to Dawn Wood Yard, a distance of 8.4 miles, the boat returning to Shreveport the latter date.

Accompanied by chief State engineer of Louisiana, H. B. Richardson, assistant State engineer, F. M. Kerr, and assistant engineer, H. M. Marshall, September 17–29, I made an inspection trip on the *Howell* from Shreveport, La., to Blanton Bluff, Ark., 70¾ miles upstream, and thence down to Alexandria, La., a total distance of 352 miles; a trip which would have been impossible a few years ago at the low stage of water. The boat was run by daylight only, and the river and levees for the entire distance were inspected. While crossing Rock River Bar, just above Grandecore, La., September 25, the *Howell* struck a snag, which ripped through the forward, second, and third compartments. The leak was stopped temporarily and the boat continued down to Alexandria, reaching that place at 5.30 p. m. September 29. Material for repairs was ordered at once from New Orleans, and the boat remained at Alexandria until October 15. The repairs of the *Howell's* bottom were completed that date and it left for work in the river below.

One day was spent in putting in about 300 feet of wing dam, built of sacks filled with earth, to deepen the channel at Alexandria Bar, and October 17–25 the crew was employed in building brush dams to scour the channel at Snaggy Point Bar. From October 25 to December 17 the *Howell* was employed in again going over the river back to Shreveport. This was a period of extraordinary low water, being below zeros of the gauges at Alexandria and Shreveport the entire time; the readings at the former place ranging from −2.2 to −0.7, and at the latter place from −5.5 to −4.2. Steamboat traffic above Montgomery was suspended, and for the greater portion of the time boats did not run above Alexandria. Progress of the *Howell* necessarily was slow, nearly every bar being passed with difficulty. October 28 a wing dam was built at Stonewall, which within twenty-four hours gave a depth of 3½ feet where there had been but 2 feet before. The boat passed Alexandria Falls without trouble, but stopped October 30 long enough to remove a pile of loose rock under draw span of the bridge. At Swilly Bar, 5½ miles above Alexandria, but 20 inches depth of channel was found. A wing dam was built, and on the morning of November 3 the *Howell*, drawing 3 feet, passed up without trouble. This work enabled boats to run above Alexandria to Montgomery, 52 miles. Above Swilly to St. Andre Bar work consisted of removing snags, stumps, and logs from the channel and cutting out bars with the

wheel sufficiently to permit the boat to pass up, which left a channel depth of at least 3 feet behind. St. Andre Bar was found impassable, and November 6 and 7 about 250 feet of brush dam were built, after which the *Howell* passed up. Before construction of this dam the small commercial steamer *Nat F. Dortch*, drawing 15 inches, lost fifteen hours' time pulling over the bar. The *Howell* pulled over the bars at Lodi, O. K., Prudhomme, and Shire with very little trouble, but passed the bar at Tessier with difficulty, as there was but 20 inches depth, and a channel had to be cut with the wheel. At Golconda Bend a narrow chute was cleared of caved-in trees before the boat could pass. Above Golconda to Campti the river was in good navigable condition, except for a few snags. November 19 and 20 the *Howell* pulled over Lower Coushatta and Rosa bars, and crossed Marcy Bar on the 22d, leaving a good channel. November 23 it passed over the bar at Mme. Josie Perot's with little trouble, and on the 24th reached Tucker Reach, which was obstructed by cypress stumps, logs, and snags, with but 2 feet depth over them, through which a channel was cleared with explosives. On the 27th the boat pulled over Kenilworth Bar, where there was but 26 inches depth. Coushatta and Capital bars were crossed November 29 without trouble, but much difficulty was experienced at Glen Martin on the 30th, where there was but 25 inches depth and the shifting sand filled in around the boat, but after parting every line the *Howell* finally crossed the bar late in the afternoon. Above Glen Martin to Shreveport, 87.3 miles, December 1–17, bars at the following places were pulled over with more or less difficulty, viz, Somerset, Loco, Pecan Point, Ashland, McKinney Bend, Nelson, Williams, Panola, and Mound Flat. December 15 it was found that a hole about 16 feet long had been knocked through the thin iron bottom of the vessel, which was closed temporarily by battens braced with stanchions from the deck. On reaching Shreveport the night of December 17 (gauge reading 4.5 feet below zero), it was found that the channel through the draw span of the bridge was closed to navigation, but 5 to 6 feet depth was found under the fixed span on the Shreveport side. During the remainder of the month of December the *Howell* remained at Shreveport, undergoing repairs necessary before continuing work above that place.

The channel through the draw span of the Shreveport Bridge being still closed, on the 1st of January (gauge reading 4.6 feet below zero), the chimneys of the *Howell* were lowered and it passed under the fixed span, to be available for work in the upper river. On the 2d and 3d a temporary wing dam was built to prevent further scour toward the west bank, the chimneys were put back, coal and supplies taken aboard, and the afternoon of January 4 the boat left for work above Shreveport. Between that date and March 8 operations were carried upstream to Fulton, Ark. Ample depth of water was found in the old raft region, and by the removal of logs, stumps, snags, and wrecks, and by cutting a channel about 75 feet wide through wrack heaps low-water navigation was rendered safe. The wrecks of four steamboats and two barges were removed, viz: January 19, sunken barge above Fire Point, La.; January 19, wreck of unknown side-wheel steamboat, supposed to be the *Quarrier* (sunk between 1850 and 1860), and a sunken barge, at Hurricane Bluff; January 21, wreck of large steamer, supposed to be the *Patsey Miller* (sunk 1875), at Hurricane Bluff; January 26, wreck of steamer *Welcome* (sunk 1884), at Carolina Bluff; and January 28, unknown wreck at Rush Point, covered with snags, logs, and stumps, supposed to be the *Black Hawk* (sunk between 1850 and 1860). Until the low-water season of 1893 these wrecks were reported as no obstruc-

tion to navigation, and rarely, if ever, were in sight. In November, 1893, all parts of the *Quarrier*, *Patsey Miller*, and *Black Hawk* then in the way of navigation were removed, but the incessant scour during the following year lowered the bottom of the river and uncovered more of them. By means of dynamite, boilers and other heavy ironwork were destroyed, and such portions as remained under the bottom of the river, and which could not be got at, will be removed from time to time as opportunity is given. Above the raft region operations were pushed as rapidly as possible in order to reach Fulton before a rise should set in, the season being late with probability that high stages might be expected soon. Low water continued, however, and as far as Garland the stages were favorable for the removal of all obstructions. Above Garland the water was too low to do more than clear a channel 65 to 75 feet wide through the wrack heaps which showed at places. As this was the lowest stage at which a boat as large as the *Howell* ever navigated this part of the river, great caution was necessary to prevent injury to the hull from striking hidden logs and stumps. To guard against accidents, the sweep chain was kept out all the way, and prevented damage in several instances. Operations were retarded somewhat by severe cold weather in February, it being impracticable to handle frozen lines, and at such times the crew was employed cutting wood, there being little fuel to be bought along the banks. On reaching the bar one-fourth mile below Dooley Ferry February 22, but 2 feet depth was found, and, as it was inadvisable to continue farther, the crew was reduced to a minimum and the boat tied up to await a slight rise. March 1–3 the river rose 1.3 feet, and March 4–8 the *Howell* worked from Dooley Ferry up to Fulton, 25.8 miles.

During the period March 9–May 7, 1895, the *Howell* was transferred to the work of improving Red River above Fulton. May 8 the boat resumed work at Fulton, and May 8–14 carried operations downstream to Shreveport. On the way it stopped at all log piles and used the sweep chain over them; a log pile and towhead at Cowhide Bayou were blown up and destroyed; and the river above Shreveport was left in good navigable condition. After arrival at Shreveport steamboat men reported a number of snags in the channel between that place and Alexandria, and, a list of the obstructions having been obtained, the *Howell* left the morning of May 16 to work below Shreveport, and reached Alexandria May 18, having removed all obstructions reported to be dangerous on the way down. May 20–28 it worked back to Shreveport, using the sweep chain at all log piles and wherever a ripple indicated a snag, removing all obstructions that could be found. May 29 the crew was laid off temporarily.

During the month of June the snag boat was laid up at Shreveport, undergoing repairs of machinery, temporary repairs of iron bottom, etc., to be available for continuing operations as soon as practicable.

The following is a summary of the work done by the *Howell* between Fulton and the Atchafalaya during the fiscal year ending June 30, 1895, viz:

Snags pulled	2,550
Stumps pulled	518
Shore snags cut	704
Logs removed from channel	7,692
Mud lumps destroyed	4
Towheads removed	1
Side jams removed	14
Leaning trees cut	549
Hard clay points removed with explosives	3
Linear feet of wing dams built	2,915
Parts of wrecks removed	7

To aid in improving the river above Shreveport and supplement work of the snag boat *Howell* a chopping party was organized December 17 to remove shore snags, stumps, etc., at the low stage of water and clear the banks where caving. This work was done under the supervision of Overseer E. P. Allen, and December 17–March 10 it was carried from Shreveport upstream to Kountz Canal, a distance of 58¾ miles. As the river had commenced rising, the party turned back at the latter place, and March 11–13 returned to Shreveport. On reaching Shreveport the outfit of tools, etc., was stored and the party disbanded.

The following is a summary of the work done by the chopping party, viz:

Stumps cut and blown up	2,382
Shore snags removed	18,536
Jams removed	1
Side jams removed	24
Leaning trees cut	840
Square yards willows and brush cut	200

LITTLE RIVER.

This stretch of Red River, 17½ miles in length between Scopini and Knox Point, was provided for by special allotment in the act of September 19, 1890. My project contemplated frequent attacks by the snag boats, with intervals to allow the river to scour after the logs should have been removed from the bed. The general plant of the district was used from time to time in passing over this reach, but very little need of work was found. It has gone on improving by the natural action of the river, notwithstanding that no great volume of water has been sent down from the upper river as compared with the average. There has been no flood thus far this year, as the term is generally understood. The highest reading on the Shreveport guage was 12.10 feet June 30, river rising slowly, with moderate amount in the upper river; the maximum being 23.6 feet below the highest recorded stage. The river was below zero at Shreveport for one-hundred and ninety-nine days, from July 16, 1894, to January 30, 1895; and again below zero between February 8 and March 11. It reached its lowest stage December 2, and was over 4 feet below zero from October 20, 1894, to January 24, 1895, or ninety-seven days continuously. Navigation was not interrupted, however, by this condition of affairs, for with the reduction of the low-water limit, which has been going on ever since the raft was removed, the general depth has been gaining.

The amount expended on Little River during the fiscal year from the special allotment was $727.56, leaving available $12,999.85. It is my opinion that Little River can be kept in good condition by following the adopted plan of occasional work, or work at any special point when required for the immediate needs of commerce, and I therefore recommend that the balance be transferred to the allotment for general improvement in order that it may not be tied up, but used to the best advantage. This will require legislative action.

ALEXANDRIA.

It has not been possible to carry on the work at Alexandria according to the approved project for want of plant of the right kind at the proper time. The dredge *Lone Star*, the only one in this district, was engaged on the work at Catahoula Shoals until the end of the calendar

year, when it was towed to Monroe to be overhauled and repaired. Unfortunately for this work there has been no high water on Ouachita River this season, and plan for docking the hull could not be executed. Highest water at Monroe corresponds to about 48.5 on the present gauge, and the dock was prepared for a mean height of 35 feet, but the river has not risen to within 10 feet of the lowest high water known, so that while the machinery has been put in good order the hull has not been rebuilt as expected, and only patching can be done.

Authority has been obtained for purchase of a ladder dredge of the Bucyrus make, and it is hoped that the work at Alexandria may be taken up the coming autumn, although there are so many demands for small amounts of dredging in portions of the district quite distant from each other that it may be necessary to delay until next season. The character of the work is such that it can not be done to advantage or economically by contract.

SULPHUR RIVER.

This item was added to Red River in the act of August 17, 1894, presumably upon my report of an examination of that stream in 1893. It is intended to begin operations first by chopping parties, and supplement it by the use of one of the smaller snag boats. No dredging can be undertaken intelligently without a survey, which, however, need not be elaborate, but limited to those parts which appear by ordinary soundings to require it.

CONSTRUCTION OF LEVEES.

Of the appropriation by act of August 17, 1894, the sum of $60,000 was allotted for levee work. After completion of the inspection of the river from Blanton Bluff to Alexandria, made the latter part of September, 1894, and after consultation with the State engineers, it was decided that the work of first importance was the building of the line along the left bank of the stretch known as Little River from Scopini to Ash Point, in Bossier Parish, La. The preliminary survey was made early in October, the work was advertised October 20, and bids for constructing the levee were received as shown by the following abstract:

Abstract of proposals for constructing levee from Scopini to Ash Point, on Red River, in Bossier Parish, La., received in response to advertisement dated October 20, 1894, and publicly opened at United States Engineer Office, Vicksburg, Miss., at 12 o'clock noon, November 5, 1894.

No.	Name and address of bidder.	Price per cubic yard.
		Cents.
1	Michael Hunt, Missionary, La	15.9
2	Carson, Barbour & Ruffe, Convent, La	15.43
3	J. A. Andrews & Co., Baton Rouge, La	14.50
4	Altringham Construction Co., Natchez, Miss	15.00
5	John Scott & Sons, St. Louis, Mo	14.39
6	William Robson & Son, Robson, La	15.00

The contract was awarded to John Scott & Sons, the lowest bidders, and agreement was entered into with them November 10, 1894, providing that the levee should be completed by March 1, 1895. The work was done under the supervision of Inspector Hunter Stewart, and was finished February 27, 1895. The line is 13,497 feet in length, and con-

tains 261,455.4 cubic yards of embankment. The levee has a crown of 8 feet, slopes of 3 base to 1 perpendicular, and grade of 3 feet above high water of 1894, or an average net fill of 11.9 feet. I visited and inspected the completed levee and received the work from the contractors March 1, 1895.

In April the old levee in front of the new line was cut in four places, to prevent disaster from sudden rush of water against the new work in case of flood, as happened at Richmond Bayou Levee in March, 1894, and in May portions of the new line were resodded where the grass had been killed by excessive cold weather.

June 24, 1895, the Secretary of War authorized an additional allotment of $33,750 for levee work, making a total available June 30 for that purpose of $54,498.41. It is proposed to apply this amount to building what is known as the Coushatta and Hervey Canal Levee, on right bank of Red River, in Caddo Parish, La., beginning about 47 miles above Shreveport and extending about 8½ miles upstream, parallel to the river. The work will consist of raising and enlarging the levee built below Red Bayou by the State of Louisiana and the Caddo Levee district board in 1892–93 to a grade not less than 3 feet above the line of high waters of 1892 and 1894, requiring an approximate embankment of 46,500 cubic yards, and constructing a new levee from the upper end to and across Hervey Canal, if funds will permit. The new line will include closing Red Bayou outlet, will be built to a net grade of not less than 3 feet above high waters of 1892 and 1894, and the amount of embankment required is approximately 375,000 cubic yards. The work was advertised June 26, 1895, and bids will be opened July 15.

The following table, furnished by the board of State engineers of Louisiana, shows in a concise manner the work on Red River undertaken during the year by the State and the levee districts:

Tabulated statement showing levee work on Red River undertaken by the State of Louisiana and local levee districts under contracts entered into during the fiscal year ending June 30, 1895.

Name of contract.	Parish.	Below Fulton.	Date of—		New levee.	Enlargement.	Quantity.	Price per cubic yard.	Cost.		Per cent of work done.
			Contract.	Final certificate.					District fund.	General engineer.	
Caddo Levee district.											
By the State:		*Miles.*			*Lin. feet.*	*Lin. feet.*	*Cu. yards*	*Cents.*			
Coushatta and Dooley Bayou	Caddo	141.5 to 145.5	Sept. 18, 1894	Mar. 2, 1895	941	12,059	35,294	13.25		$4,676.45	100
Wild Lucia and Crescent	do	148.3 to 149.3	do	Dec. 29, 1894		7,200	20,179	12.38		2,498.16	100
Cedar Bluff	do	149.3 to 152.5	do	Mar. 2, 1895		13,300	53,564	12.38		6,631.22	100
Total					941	32,559	109,037			13,805.83	
By the district:											
Coushatta and Dooley Bayou*	Caddo	141.5 to 145.5		Mar. 2, 1895					$152.79		100
Cedar Bluff bulkheads	do	151		Mar. 4, 1895					480.00		100
Eagle Bend	do	197.3	Nov. 20, 1894	Mar. 27, 1895	1,692		21,522	14.44	3,107.78		100
Staten Point†	do	203.5 to 206.5	do	do		.970	6,110	14.44	882.28		100
Tones Bayou bulkheads	do	206.5		Mar. 29, 1895					500.00		100
Tones Bayou spurs	do	206.5	Nov. 20, 1894	Mar. 27, 1895		455	4,877	14.44	704.24		100
Long Branch	do	209.5	Mar. 5, 1895	Mar. 20, 1895		1,056	2,806	10.00	280.60		100
Brown	do	212.75 to 213.5	Nov. 20, 1894	Mar. 27, 1895		5,100	13,484	14.44	1,947.09		100
Cash	do	215	do	do		1,000	1,491	14.44	215.30		100
Ashwood	do		do	do		2,000	4,700	14.44	678.68		100
Upper Pascagoula	do		do	do		3,033	10,612	14.44	1,532.37		100
Lower Pascagoula	do	221	do	do		2,100	5,430	14.44	784.09		100
Upper Logie Lea	do	221.5	do	do		3,371	11,699	14.44	1,689.34		100
Lower Logie Lea	do	222	do	do	978		10,850	14.44	1,566.74		100
Upper Magnolia	do	223	do	do	3,900		36,612	14.44	5,286.77		100
Lower Magnolia	do	227.75	do	do	2,616		28,184	14.44	4,069.77		100
Caspiana	do	227.75 to 228.5	Mar. 5, 1895		6,200		29,094	12.74	3,706.58		100
Whitehall	do	228.5 to 232	do		15,900		84,566	12.74	10,773.71		100
Campo Bello‡	do	232 to 236	do		5,950	760	51,395	12.74	6,547.72		100
Cross Keys	do	236 to 237.5	do		11,700		53,416	12.74	6,805.20		100

Beaird and Bonner	do	237.5 239.5	do		7,150	750	27,065	12.74	3,448.08	100
Total					56,086	20,595	403,913		55,159.13	
Bossier Levee district.										
By the State:										
Sunflower	Bossier	195 195.5	Sept. 18, 1894	Mar. 4, 1895	3,492	800	49,077	9.33⅓	4,580.52	100
Knox Point to Buckhorn	do	225 234.75	Feb. 2, 1895	Apr. 22, 1895	33,577		199,017		3,497.00	100
Total					37,069	800	248,094		8,077.52	
By the district:										
Scopini	Bossier	206.5 207.5		Dec. 29, 1894		5,260	12,032	16.00	1,925.12	100
Waterloo Point to Navigator Point	do	213 214.75	Oct. 18, 1894	Apr. 1, 1895	9,984		131,787	14.75	19,438.58	100
White House	do	219.5	Apr. 18, 1895	June 17, 1895	234		1,191	9.00	107.19	100
Knox Point to Buckhorn *	do	225 234.75	Feb. 2, 1895	Apr. 27, 1895					17,500.00	100
Total					10,218	5,260	145,010		38,970.89	
Red River, Atchafalaya, and Bayou Bœuf Levee district.										
By the State:										
Connella §	Rapides	412.5	June 13, 1894	Nov. 2, 1894	3,300	7,827	86,758	9.96	8,658.44	100
Dorman §	do	415.75 416.75	do	Nov. 19, 1894	3,572	1,163	53,546	9.44	5,054.74	100
Carter	do	417.5 419	do	do	1,057	5,498	37,832	9.44	3,571.34	100
Wilson §	do	421.25 426	do	Nov. 21, 1894	6,231	4,857	89,677	10.75	9,640.27	100
Total					14,160	19,345	267,813		26,924.79	
Total work undertaken					‖ 118,474	¶ 78,499	1,173,867		94,130.02	48,808.14	

NOTE.—Cash crevasse, 32,458 cubic yards, reported 50 per cent done June 30, 1894, was completed in July, 1894, and Riverdale to Tones Bayou, 42,788 cubic yards, reported 35 per cent done June 30, 1894, was completed in July, 1894.

* Yardage given under State work.

§ Reported in table for fiscal year 1894, but no work done that year.

† Across point to Tones Bayou.

‖ Or 22.44 miles.

‡ Across point.

¶ Or 14.87 miles.

SURVEY.

The survey of Red River from Fulton, Ark., to Atchafalaya River, Louisiana, a distance by channel measurement of 818.5 kilometers (508.6 miles), practically is finished, with exception of a few map sheets. Details of the year's work are given in Assistant Engineer Marshall's report herewith.

As stated in my last report, the survey would be more valuable for geographical purposes if secondary triangulation and transvalley sections could be carried out; but neither is absolutely necessary, as the study of the best means of improvement does not require the former, and the fact that both United States and State engineers are in perfect accord upon the subject of confining the river by closing outlets and building levees renders it of small moment what material lies on either side the immediate banks, or whether the lands rise or fall away. The general fall of the valley from Fulton to the Mississippi is known, and we have the most exact information that has been obtained on any river of like magnitude of the fall per unit of the water surface at extreme stages. The rapid reconnaissances of 1893 and 1894—rapid because the frequency of permanent reference points of triangulation and elevation enabled the parties to get definite information without delaying to identify positions where changes had taken place—have been developed upon the office maps, from which we may get an accurate measure of the amount of change at any point and the time.

For working drawings and for convenience in plotting future changes of the river, it would be well to have published a small edition, say 200 copies, of the maps on the original scale of 1:10,000, and a larger edition, say 500 copies, for general use on scale of 1:20,000, giving sheets one-fourth the size of the originals and conforming with the published maps of Mississippi River. It is estimated that an edition of 200 on the large scale, on good paper, will cost $2,500, and one of 500 on the small scale $5,000.

REPORT OF MR. H. M. MARSHALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 20, 1895

CAPTAIN: I have the honor to submit the following report on Red River survey:

About the middle of September a party under Assistant Engineer G. C. Haydon, quartered on a small flat, as in the previous season, began work at mouth of Sulphur River, and by the first week in December reached the mouth of Black River.

The work comprised testing and resetting low-water gauges at intervals of about 7 kilometers, making local survey of the shoals, and taking discharge. The methods and programme were the same as prevailed in previous seasons, and have been fully described in earlier reports.

Table 1 gives the elevation of low-water surface derived from gauge readings and the local surveys; the latter having been reduced from actual observed values by the amount of the change at adjacent gauges. This simply supposes no alteration of slope between consecutive gauges during the interval between the local survey and low water, which is not a violent assumption, inasmuch as the change of stage was usually less than half a meter.

Table 2 gives the elevation of the water surface covering the period of "low water" and extending over fifteen days. At a few points the elevations have been interpolated and are noted as such.

Table 3 gives the results of discharge measurements.

Five profile sheets showing high waters of 1892 and 1894, low water of 1894, and bottom of the channel at time of survey in 1893, except between Posten Bayou and Shreveport, where survey was made in 1892 and omitted in 1893, and over the shoals and at gauge stations where the depths are those measured in 1894.

Table 4 gives results of the borings made within the river bed in 1893. The method and analysis were the same as obtained on Yazoo River, and are fully described in Chief of Engineers' Report, 1894, page 1493. The diagram sheet illustrates the proportion of the different sizes of material which compose the bars in each locality from Fulton to Alexandria. While they show that the proportion of the larger material, gravel, is greater in the upper than in the lower river, they also show that by far the greater part of all the bars is made up of material less than half a millimeter in diameter. The bars are the effects of conditions which exist within the river, and are evidences of the misapplication of the energy of the water. It must not be overlooked that the fine material is sand, and is not retained in place by cohesion; but was brought by currents able to transport it, and the place of deposit marks where those currents became incapable of carrying it.

In the office all data have been worked up and tabulated, save a few soundings taken in 1879 between Colfax and Alexandria and the results of the surveys made under Maj. W. H. H. Benyaurd in 1880 and 1881, near the mouth of the river. All the final map sheets have been plotted on scale of 1:10,000, but 20 of the 64 are yet without the topographical signs. Index chart has been made in three sheets on scale of 1:200,000. Survey of 1893 and local bar surveys of 1894 have been plotted. Of the former, 34 sheets have been added to the tracings in colors, so as to show the changes which have taken place.

It will be seen that little remains to be done to make available all information at hand, and only by long, systematic observation could any material addition be made to that already gathered. Within a short time it is to be expected everything will be ready for a report on "A plan for the permanent improvement of Red River."

Very respectfully, your obedient servant,

H. M. MARSHALL,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana.*

LOW-WATER MARKS OF 1894 FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
ARKANSAS.	*Kilos.*	*Meters.*		*Meters.*
Fulton	0.0	75.47	Nov. 27–Dec. 7	
Dobson Landing, Gauge No. 8	*56.9 65.7	70.58	Nov. 29–Dec. 2	0.086
Garland	93.2	68.45	Nov. 30–Dec. 2	0.077
Sulphur River, Range 1	†167.1 172.1	63.35		0.069
Mouth Sulphur River, Range 2	172.7	63.31		0.066
Sulphur River, Gauge No. 21	173.1	63.30	Dec. 2	0.025
Collins Bluff	173.5	63.29		0.025
Diggs Bluff, Gauge No. 22	180.0	63.17	Dec. 2, 3	0.018
Blanton Bluff, Gauge No. 23	189.3	62.55	Dec. 2	0.067
LOUISIANA.				
Missionary Place, Gauge No. 24	194.5	62.34	Dec. 2	0.040
Bargetown Slough:				
Range 10	195.4	62.28		0.066
Range 11	195.9	62.27		0.020
Range 12	196.2	62.27		0.000
O'Rourke Slough:				
Range 13	198.5	61.95		0.139
Range 14	198.7	61.89		0.300
Range 15	198.9	61.88		0.050
Boone Bend, Gauge No. 25	200.1	61.85	Dec. 5	0.025
Alban Canal No. 2:				
Range 16	202.8	61.72		0.048
Range 17	203.0	61.71		0.050
Range 18	203.2	61.69		0.100
Kouns Canal:				
Range 19	207.8	61.40		0.063
Gauge No. 26	208.1	61.35	Dec. 5	0.167
Range 21	208.3	61.35		0.000

* Measured through Ferguson Cut-off, Arkansas. (December 28, 1892.)
† Measured through Crowell Point Cut-off, Arkansas.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1864 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
LOUISIANA—continued.				
Harvey Canal:	*Kilos.*	*Meters.*		*Meters.*
Range 22	213.8	60.86		0.089
Range 23	214.1	60.77		0.300
Range 24	214.6	60.77		0.000
Poston Bayou:				
Range 25	217.0	60.69		0.033
Gauge No. 27	217.2	60.65	Dec. 2–9	0.200
Range 27	217.4	60.64		0.050
Red Bayou:				
Range 28	219.6	60.63		0.005
Range 29	219.9	60.59		0.133
Range 30	220.2	60.59		0.000
Fuller Inlet:				
Range 31	222.6	60.22		0.154
Range 32	222.8	60.22		0.000
Range 33	223.2	60.22		0.000
Elmer Slough, Gauge No. 28	226.1	59.97	Dec. 2	0.086
Fuller Outlet:				
Range 34	229.1	59.47		0.167
Range 35	229.4	59.44		0.100
Range 36	229.6	59.44		0.000
Dooley Bayou:				
Range 37	230.4	59.41		0.037
Range 38	230.8	59.33		0.200
Range 39	231.1	59.26		0.233
East Egypt Place, Gauge No. 29	231.8	59.21	Dec. 2	0.071
Wild Lucia	239.2	*58.60		0.082
Rush Point	248.4	*56.95		0.179
Cottonwood Bayou:				
Range 42	254.2	56.51		0.076
Gauge No. 32	254.6	56.49	Dec. 2, 3; 5–9	0.050
Range 44	254.7	56.47		0.200
Willow Bend Place	261.8	55.27	Dec. 1–5	0.169
Eric Place	267.1	*54.33		0.177
Gold Point Place	272.7	*53.23		0.196
Cash Point Place	281.1	51.92	Dec. 5	0.156
Pandora Bend:				
Range 49	287.1	50.69		0.205
Range 50	287.3	50.67		0.100
Range 51	287.6	50.61		0.200
Gauge No. 37	287.9	*50.58		0.100
Colquitt Place	295.9	*49.16		0.177
Shreveport:				
Range 53	302.4	47.66		0.221
Range 54	302.6	47.63		0.150
Range 55	302.7	47.62		0.100
Range 56	302.9	47.53		0.450
Gauge No. 39	303.2	47.47	Dec. 2–4	0.200
Range 58	303.5	47.41		0.200
Chalk Level Shoal:				
Range 59	308.8	46.94		0.088
Range 60	309.0	46.86		0.400
Range 61	309.2	46.72		0.700
Range 62	309.3	46.65		0.700
Range 63	309.6	46.57		0.267
Range 64	309.7	46.51		0.600
Nicholson Place	312.0	46.50	Dec. 7, 8	0.004
Curtis Place	319.7	*46.33		0.022
Childers Place	331.8	45.79	Dec. 2, 3	0.044
Lotus Landing	337.5	45.26		0.093
Waterloo Cut-off	342.5	44.97	Dec. 1–3	0.058
Young Point Cut-off	348.7	44.67	Dec. 2, 3	0.048
Pascagoula Place	355.4	44.12	Dec. 2	0.082
Knox Point Place	361.4	43.57	Dec. 2–5	0.091
Caspiana Place	367.7	43.25	Dec. 3, 6, 7	0.050
Campobello Place	375.2	42.91	Dec. 7	0.045
Cross Keys Place	382.7	42.10	Dec. 2	0.108
Ninock Bayou	390.7	40.88	Dec. 6	0.152
Swift Chute Bayou	395.5	40.52	Dec. 6, 7	0.075
Cotton Point Shoal:				
Range 95	395.9	40.47		0.125
Range 96	396.1	40.45		0.100
Range 97	396.2	40.44		0.100
Range 98	396.3	40.43		0.100
Range 99	396.5	40.40		0.150

*Interpolated.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1894 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation Cairo datum.	Date.	Slope per kilometer.
LOUISIANA—continued.				
Loggy Bayou Reach:	*Kilos.*	*Meters.*		*Meters.*
Range 102	404.0	39.48		0.122
Range 103	404.1	39.46		0.200
Range 104	404.3	39.44		0.100
Range 105	404.6	39.41		0.100
Loggy Bayou, Gauge No. 55	405.2	39.31	Dec. 3, 7	0.167
Nelson Place	412.0	38.85	Dec. 7, 8	0.068
Elder Grove Place	420.4	38.17	Dec. 2, 3, 8	0.081
Pecan Point Shoal:				
Range 109	428.4	37.63		0.067
Range 110	428.6	37.58		0.250
Range 111	428.8	37.51		0.350
Range 112	429.0	37.45		0.300
Pecan Point Place	429.1	37.41	Dec. 2, 3	0.400
Willow Point Place	436.8	37.01	do	0.052
Cottage Home Place	441.9	36.61	Dec. 3	0.078
Glen Martin Shoal:				
Range 116	442.7	36.44		0.212
Range 117	442.8	36.42		0.200
Range 118	442.9	36.38		0.400
Range 119	443.0	36.37		0.100
Range 120	443.2	36.36		0.050
Range 121	443.4	36.33		0 150
Range 122	443.5	36.31		0.200
Coushatta, Stone Line 21	448.3	35.51		0.167
Coushatta, Gauge No. 61	448.4	35.49	Dec. 6	0.200
Coushatta Bar:				
Range 125	448.5	35.44		0.500
Range 126	448.6	35.42		0.200
Range 127	448.8	35.42		0.000
Range 128	448.9	35.40		0.200
Cabin Row Reach:				
Range 129	450.9	35.21		0.095
Range 130	451.0	35.18		0.300
Range 131	451.1	35.17		0.100
Range 132	451.2	35.15		0.200
Range 133	451.3	35.13		0.200
Range 134	451.4	35.11		0.200
Range 135	451.6	35.05		0.300
Range 136	451.8	35.03		0.100
Range 137	451.9	35.01		0.200
Range 138	452.0	35.00		0.100
Range 139	452.1	34.98		0.200
Range 140	452.2	34.93		0.500
Range 141	452.3	34.91		0.200
Range 142	452.4	34.87		0.400
Range 143	452.5	34.85		0.200
Range 144	452.6	34.85		0.000
Range 145	452.7	34.85		0.000
Viva Landing	458.0	34.48	Dec. 2-4, 7-9	0.069
Kenilworth Landing	463.0	34.00	Dec. 2, 5-8	0.096
Brownville Place	*470.7	33.41	Dec. 3-4, 6-7	0.077
	472.2			
Lake Poule d'Eau Place	†481.5	33.03	Dec. 2-3, 6-9	0.041
	482.9			
Le Compte Bluffs	490.1	32.73	Dec. 9	0.041
Prudhomme Bar:				
Range 162	491.4	32.70		0.023
Range 163	491.7	32.67		0.100
Range 164	491.9	32.60		0.350
Range 165	492.1	32.57		0.150
Range 166	492.4	32.43		0.467
Range 167	493.2	32.29		0.175
Range 168	493.4	32.23		0 300
Rosa Bar:				
Range 169	494.0	32.05		0.300
Range 170	494.1	32.01		0.400
Range 171	494.5	31.88		0.325
Range 172	494.7	31.80		0.400
J. C. Henry Place	498.5	30.84	Dec. 1, 7-9	0.253
Hyams Place	‡507.2	§29.83		0.116
	509.0			

* Measured through Lake End Point Cut-off, Louisiana.
† Measured through Upper Brazil Place Cut-off, Louisiana.
‡ Measured through Le Vassar Cut-off, Louisiana.
§ Interpolated.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1894 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
LOUISIANA—continued.	*Kilos.*	*Meters.*		*Meters.*
Willow Place	516.9	29.04	Dec. 5–9	0.100
Tessier Landing	526.7	28.28	Dec. 2	0.077
St. Maurice	537.8	27.06	Dec. 3	0.110
O. K. Bar:				
Range 179	544.0	26.64		0.068
Range 180	544.1	26.56		0.800
Range 181	544.5	26.49		0.175
Range 182	544.9	26.37		0.300
Range 183	545.3	26.34		0.075
Range 184	545.6	26.21		0.434
O. K. Landing	547.3	25.97	Nov. 29–Dec. 2, 6, 7.	0.141
O. K. Bar:				
Range 186	548.8	25.73		0.160
Range 187	549.0	25.68		0.250
Range 188	549.2	25.60		0.400
Stone Line 32	549.7	25.47		0.260
High Die Place	554.3	25.06	Dec. 3	0.089
Bell Landing	564.7	23.95	Dec. 2, 3	0.107
St. Andre Bluff:				
Range 193	574.7	23.24		0.071
Gauge No. 75	574.9	23.17	Nov. 30–Dec. 3, 7	0.350
Range 195	575.0	23.14		0.300
Range 196	575.2	23.08		0.300
Range 197	575.3	23.05		0.300
Range 198	575.4	23.02		0.300
Range 199	575.5	22.97		0.500
Colfax	585.8	22.13	Dec. 2–4	0.081
M. E. Landing	593.5	21.67	Dec. 2	0.059
Fairmount Place	600.8	21.00	Dec. 2, 3	0.089
Lower Flagland Place	608.9	20.73	Dec. 3	0.034
Belleview Place	617.0	20.48	Dec. 2, 3	0.034
China Grove Place	626.4	20.33	Dec. 3	0.015
Swilley Bar:				
Range 206	631.8	19.97		0.067
Range 207	632.0	19.94		0.150
Range 208	632.1	19.92		0.200
Range 209	632.16	19.90		0.333
Range 210	632.25	19.90		0.000
Range 211	632.30	19.88		0.400
Range 212	632.35	19.87		0.200
Range 213	632.5	19.87		0.000
Above Houston, Central Arkansas and Northern R. R. Bridge	637.5	19.56	Dec. 2	0.062
Upper Alexandria Falls:				
Range 216	637.6	19.53		0.300
Range 218	637.75	19.50		0.200
Range 221	637.84	19.47		0.333
Range 222	637.87	19.44		1.000
Range 223	637.91	19.55		2.250
Range 224	637.94	19.24		3.667
Range 228	638.06	19.24		0.000
Range 231	638.15	19.24		0.000
Range 238	638.4	19.24		0.000
Texas and Pacific Incline:				
Range 234	638.6	19.22		0.100
Range 235	638.8	19.22		0.000
Range 236	639.1	19.22		0.000
Alexandria Upper Discharge Section	639.4	19.21		0.033
Lower Alexandria Falls:				
Range 239	639.5	19.21		0.000
Range 240	639.6	19.08		1.300
Range 241	639.7	18.98		1.000
Range 242	639.9	18.98		0.000
Alexandria Harbor:				
Range 243	640.1	18.97		0.050
Range 244	640.3	18.97		0.000
Range 245	640.5	18.97		0.000
Alexandria Gauge	640.8	18.97	Dec. 2, 3	0.000
Alexandria Harbor:				
Range 247	640.9	18.93		0.400
Range 248	641.0	18.87		0.600
Range 249	641.2	18.87		0.000
Range 250	641.3	18.85		0.200
Range 251	641.5	18.84		0.050
Range 252	641.6	18.84		0.000

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1894 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
LOUISIANA—continued.				
	Kilos.	*Meters.*		*Meters.*
Cut-off Place	648.3	17.97	Dec. 2, 3	0.129
Hathorn Reach, Range 254	657.2	17.60		0.041
Hathorn Place, Gauge No. 84	657.3	17.58	Dec. 2, 3	0.200
Hathorn Reach:				
Range 256	657.4	17.58		0.000
Range 257	657.5	17.57		0.100
Range 258	657.6	17.56		0.100
Range 259	657.7	17.56		0.000
Hortensia Place	666.0	17.28	Dec. 3	0.033
Dorman Reach:				
Range 261	669.2	17.26		0.006
Range 262	669.27	17.23		0.428
Range 263	669.34	17.21		0.285
Range 264	669.42	17.19		0.250
Range 265	669.48	17.19		0.000
Range 266	669.68	17.17		0.100
Range 267	669.83	17.16		0.200
Range 268	669.98	17.12		0.267
Range 269	670.08	17.10		0.200
Range 270	670.15	17.08		0.285
Range 271	670.22	17.06		0.285
Range 272	670.29	17.06		0.000
Casa Landing	673.6	17.04	Dec. 2, 3	0.006
Grimes Bluff:				
Gauge No. 87	681.5	16.78	Nov. 30	0.033
Range 275	681.6	16.77		0.100
Range 276	681.7	16.72		0.500
Range 277	681.9	16.70		0.100
Range 278	682.0	16.68		0.200
Egg Bend	690.3	16.54	Dec. 3	0.016
Cassandria:				
Gauge No. 89	699.3	16.46	Dec. 2, 3	0.009
Range 281	699.6	16.45		0.033
Range 282	700.0	16.45		0.000
Snaggy Point:				
Range 283	700.1	16.45		0.000
Range 284	700.2	16.45		0.000
Range 285	700.3	16.42		0.300
Range 287	700.4	16.41		0.100
Range 289	700.5	16.38		0.300
Range 290	700.6	16.35		0.300
Range 292	700.7	16.28		0.700
Range 294	700.8	16.24		0.400
Range 295	700.9	16.21		0.300
Range 296	701.0	16.16		0.500
Range 298	701.2	16.03		0.650
Range 299	701.4	15.96		0.350
Range 300	701.6	15.91		0.250
Range 301	701.9	15.81		0.333
Range 302	702.1	15.73		0.400
Range 303	702.3	15.66		0.350
Experiment Station:				
Range 304	702.4	15.64		0.200
Range 305	702.5	15.58		0.600
Range 306	702.6	15.53		0.500
Range 307	702.7	15.50		0.300
Range 308	702.9	15.45		0.250
Range 309	703.2	15.29		0.533
Range 310	703.5	15.19		0.333
Dauzat Place	705.8	14.98	Dec. 2	0.091
Normand Landing	716.9	14.19	Dec. 3	0.071
Tassin Place:				
Range 313	719.1	14.09	do	0.045
Range 314	719.2	14.06	do	0.300
Range 315	719.3	14.05	do	0.100
Range 316	719.4	14.02	do	0.300
Range 317	719.5	14.02	do	0.000
Range 318	719.7	13.94	do	0.400
Range 319	719.8	13.94	do	0.000
Range 320	719.9	13.94	do	0.000
Range 321	720.0	13.93	do	0.100
Range 322	720.1	13.89	do	0.400
Range 323	720.2	13.86	do	0.300

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1894 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
LOUISIANA—continued.				
Barbin Place:	*Kilos.*	*Meters.*		*Meters.*
Range 324	720.3	13.82	Dec. 3	0.400
Range 326	720.4	13.81	do	0.100
Range 327	720.6	13.73	do	0.400
Range 328	720.8	13.62	do	0.550
Range 329	721.0	13.53	do	0.450
Range 330	721.1	13.50	do	0.300
Range 332	721.2	13.47	do	0.300
Barbin Landing:				
Range 333	721.3	13.44	do	0.300
Range 334	721.4	13.42	do	0.200
Ware Landing	722.0	13.32	do	0.166
Brouillette Landing	728.8	*12.89		0.063
Saline Bayou	737.8	*11.77		0.124
Double Eddy Landing	742.4	*11.60		0.030
Murry Place	750.1	*11.22		0.049
Old Harris Place	760.1	*10.08		0.114
Little Larto Landing	765.5	*8.87		0.224
Black River Reach:				
Range 342	772.3	7.78		0.160
Range 343	772.4	7.77		0.100
Range 344	772.6	7.76		0.050
Range 345	772.8	7.64		0.100
Range 346	772.9	7.63		0.100
Range 347	773.0	7.60		0.300
Range 348	773.2	7.56		0.200
Range 349	773.3	7.52		0.400
Range 350	773.4	7.50		0.200
Range 351	773.6	7.49		0.050
Range 352	773.7	7.47		0.200
Range 353	773.9	7.42		0.250
Black River:				
Gauge No. 97	774.0	*7.42		0.000
Range 355	774.1	7.42		0.000

*Interpolated.

TABLE 2.—*Water surfaces during low water on Red River in Arkansas and Louisiana.*

[Water surfaces during low water of 1894 from gauge records. Elevation in meters, Cairo datum.]

Place.	Distance.	Time.	November.					December.									
			26	27	28	29	30	1	2	3	4	5	6	7	8	9	10
ARKANSAS.	*Kilos.*																
Fulton	0	8 a. m.	75.51	75.49	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.49*	75.51	75.55
		4 p. m.	75.49	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	*75.47*	75.51	75.51	75.56
Dobson Landing	*56.9	8 a. m.	70.61	70.61	70.60	*70.58*	*70.58*	*70.58*	*70.58*	70.61	70.62	70.61	70.61	70.61	70.63	70.63	70.67
	65.7	4 p. m.	70.61	70.60	70.59	*70.58*	*70.58*	70.59	70.59	70.61	70.61	70.61	70.61	70.62	70.64	70.63	70.67
Garland	93.2	8 a. m.	68.48	68.47	68.46	68.46	*68.45*	*68.45*	*68.45*	68.46	68.46	68.46	68.46	68.46	68.46	68.46	68.51
		4 p. m.	68.48	68.47	68.46	68.46	*68.45*	*68.45*	*68.45*	68.46	68.46	68.46	68.46	68.46	68.46	68.46	68.51
Sulphur River	†167.1	8 a. m.	63.36	63.34	63.33	63.32	63.32	63.31	*63.30*	63.31	63.32	63.32	63.32	63.32	63.33	63.34	63.41
	172.1	4 p. m.	63.35	63.34	63.33	63.32	63.31	63.31	*63.30*	63.31	63.32	63.32	63.32	63.32	63.33	63.36	63.43
Diggs Bluff	180.0	8 a. m.	63.25	63.23	63.22	63.21	63.20	63.19	*63.17*	*63.17*	63.19	63.19	63.20	63.21	63.21	63.21	63.22
		4 p. m.	63.24	63.23	63.22	63.21	63.20	63.18	*63.17*	63.18	63.19	63.19	63.20	63.21	63.21	63.21	63.24
Blanton Bluff	189.3	8 a. m.	62.63	62.61	62.60	62.59	62.58	62.56	*62.55*	62.57	62.58	62.58	62.58	62.58	62.58	62.58	62.68
		4 p. m.	62.62	62.61	62.60	62.59	62.57	62.56	*62.55*	62.57	62.58	62.58	62.58	62.58	62.58	62.59	62.69
LOUISIANA.																	
Missionary Place	194.5	8 a. m.	62.42	62.40	62.39	62.38	62.37	62.35	*62.34*	62.35	62.37	62.37	62.37	62.37	62.37	.....	.....
		4 p. m.	62.41	62.40	62.39	62.38	62.36	62.35	*62.34*	62.36	62.37	62.37	62.37	62.37	62.37	.....	.....
Boone Bend	200.1	8 a. m.	.....	.....	61.91	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	*61.85*	.....	.....	.....	.....	.....
Kouns Canal	208.1	8 a. m.	.....	.....	61.38	.....	.....	.....	.....	.....	.....	*61.35*	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Posten Bayou	217.2	8 a. m.	60.72	60.72	60.69	60.68	60.67	60.66	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	60.78
		4 p. m.	60.72	60.71	60.69	60.68	60.67	60.66	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	*60.65*	60.76
Elmer Slough	226.1	8 a. m.	60.07	60.06	60.05	60.03	60.01	59.99	*59.97*	59.99	59.99	60.00	60.00	60.00	60.02	60.06	60.10
		4 p. m.	60.07	60.06	60.05	60.03	60.01	59.98	*59.97*	59.99	59.99	60.00	60.00	60.00	60.04	60.08	60.11
East Egypt Place	231.8	8 a. m.	59.30	59.28	59.26	59.25	59.24	59.23	*59.21*	59.22	59.24	59.24	59.24	59.24	59.25	59.25	59.33
		4 p. m.	59.29	59.27	59.26	59.25	59.24	59.22	*59.21*	59.23	59.24	59.24	59.24	59.25	59.25	59.26	59.35
Wild Lucia	239.2	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	‡*58.60*	.....	.....	.....	.....	.....	.....	.....	.....
Rush Point	248.4	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	‡*56.95*	.....	.....	.....	.....	.....	.....	.....	.....
Cottonwood Bayou	254.6	8 a. m.	56.57	56.56	56.54	56.53	56.52	56.51	*56.49*	*56.49*	56.50	56.50	*56.49*	*56.49*	*56.49*	*56.49*	56.55
		4 p. m.	56.57	56.55	56.54	56.52	56.51	56.50	*56.49*	56.50	56.50	*56.49*	*56.49*	*56.49*	*56.49*	56.50	56.57
Willow Bend Place	261.8	8 a. m.	55.35	55.34	55.33	55.30	55.29	*55.27*	*55.27*	*55.27*	*55.27*	*55.27*	55.29	55.29	55.30	55.32	55.35
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Eric Place	267.1	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	‡*54.39*	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gold Point Place	272.7	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	‡*53.23*	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Measured through Ferguson Cut-off, Arkansas (December 23, 1892). † Measured through Crowell Point Cut-off, Arkansas. ‡ Interpolated.

TABLE 2.—*Water surfaces during low water on Red River in Arkansas and Louisiana*—Continued.

Place.	Distance.	Time.	November.					December.									
			26	27	28	29	30	1	2	3	4	5	6	7	8	9	10
LOUISIANA—continued.																	
	Kilos.																
Cash Point Place	281.1	8 a. m.	52.16	52.14	52.11	52.08	52.06	52.03	.....	.....	.....	*51.92*	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pandora Bend	287.9	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	†*50.58*	.....	.....	.....	.....	.....	50.63
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.70
Colquitt Place	295.9	8 a. m.	.....	.....	.....	.....	.....	.....	.....	†*49.16*	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shreveport	303.2	8 a. m.	47.52	47.52	47.50	47.50	47.50	47.50	*47.47*	*47.47*	*47.47*	47.50	47.50	47.50	47.53	47.53	47.72
		4 p. m.	47.52	47.50	47.50	47.50	47.50	47.50	*47.47*	*47.47*	47.50	47.50	47.50	47.57	47.53	47.53	47.66
Nicholson Place	312.0	8 a. m.	46.64	46.62	46.60	46.59	46.58	46.57	46.56	46.57	46.56	46.56	46.51	*46.50*	*46.50*	46.60	46.75
		4 p. m.	46.63	46.61	46.60	46.59	46.57	46.56	46.56	46.57	46.56	46.56	46.51	*46.50*	*46.50*	46.61	46.74
Curtis Place	319.7	8 a. m.	46.44	46.42	46.40	.....	.....	.....	.....	.....	.....	.....	†*46.33*	.....	46.42	46.40	46.57
		4 p. m.	46.43	46.41	.....	.....	.....	.....	.....	.....	.....	.....	.....	46.40	46.41	46.40	46.56
Childers Place	331.8	8 a. m.	45.88	45.87	45.86	45.84	45.82	45.80	*45.79*	*45.79*	45.82	45.82	45.81	45.81	45.86	45.85	45.99
		4 p. m.	45.87	45.86	45.85	45.83	45.81	45.80	*45.79*	*45.79*	45.82	45.82	45.81	45.82	45.86	45.85	46.01
Lotus Landing	337.5	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	†*45.26*	.....	.....	.....	.....	.....	.....	.....	.....
Waterloo Cut-off	342.5	8 a. m.	45.06	45.05	45.03	45.00	44.99	44.98	*44.97*	*44.97*	44.99	45.00	44.98	44.98	45.01	45.01	45.15
		4 p. m.	45.05	45.04	45.01	44.99	44.98	*44.97*	*44.97*	44.98	44.99	44.99	44.98	44.99	45.02	45.08	45.16
Young Point Cut-off	348.7	8 a. m.	44.75	44.74	44.73	44.71	44.70	44.69	*44.67*	*44.67*	44.68	44.68	*44.67*	*44.67*	44.70	44.73	44.79
		4 p. m.	44.75	44.74	44.72	44.71	44.70	44.68	*44.67*	44.68	44.69	44.68	*44.67*	*44.67*	44.73	44.75	44.81
Pascagoula Place	355.4	8 a. m.	44.26	44.24	44.23	44.21	44.21	.....	.....	.....	.....	.....	.....	.....	.....	44.22	44.31
		4 p. m.	44.25	44.24	44.22	44.21	44.20	.....	*44.18*	.....	.....	.....	.....	.....	44.20	44.22	44.35
Knox Point	361.4	8 a. m.	43.65	43.63	43.62	43.61	43.60	43.59	43.58	*43.57*	*43.57*	*43.57*	43.58	43.59	43.61	43.63	43.67
		4 p. m.	43.65	43.63	43.62	43.60	43.60	43.59	*43.57*	*43.57*	*43.57*	43.58	43.59	43.59	43.61	43.65	43.67
Caspiana	367.7	8 a. m.	43.32	43.31	43.30	43.28	43.27	43.26	43.26	*43.25*	43.26	43.26	*43.25*	*43.25*	43.27	43.26	43.28
		4 p. m.	43.32	43.31	43.29	43.28	43.27	43.26	43.26	*43.25*	43.26	43.26	*43.25*	*43.25*	43.27	43.26	43.32
Campobello	375.2	8 a. m.	42.98	42.97	42.96	42.95	42.93	42.93	42.92	42.93	42.93	42.93	42.92	*42.91*	42.93	42.95	42.96
		4 p. m.	42.98	42.96	42.96	42.94	42.93	42.93	42.92	42.93	42.93	42.93	42.92	*42.91*	42.94	42.95	42.98
Cross Keys	382.7	8 a. m.	42.15	42.13	42.13	42.12	42.12	42.11	42.11	42.11	42.11	42.11	42.11	42.13	42.14	42.14	42.16
		4 p. m.	42.14	42.13	42.13	42.12	42.11	42.11	*42.10*	42.11	42.11	42.11	42.12	42.14	42.14	42.14	42.18
Ninock Bayou	390.7	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	40.89	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	40.98	.....	.....	.....	.....	.....	.....	.....	*40.88*	.....	.....	.....	.....
Swift Chute Bayou	395.5	8 a. m.	40.60	40.59	40.57	40.55	40.54	40.54	40.53	40.53	40.53	40.53	*40.52*	*40.52*	40.53	40.55	40.59
		4 p. m.	40.60	40.58	40.55	40.55	40.54	40.53	40.53	40.53	40.53	40.53	*40.52*	*40.52*	40.54	40.55	40.62
Loggy Bayou	405.2	8 a. m.	39.39	39.37	39.35	39.34	39.34	39.33	39.32	*39.31*	39.33	39.33	39.32	*39.31*	39.32	39.36	39.40
		4 p. m.	39.38	39.36	39.35	39.34	39.34	39.32	39.32	39.33	39.33	39.33	39.32	39.32	39.33	39.37	39.43
Nelson Place	412.0	8 a. m.	38.92	38.91	38.90	38.89	38.88	38.87	38.86	38.87	38.86	38.87	38.86	*38.85*	*38.85*	38.87	38.93
		4 p. m.	38.92	38.91	38.90	38.89	38.88	38.87	38.86	38.87	38.86	38.87	38.86	*38.85*	*38.85*	38.80	38.95
Elder Grove Place	420.4	8 a. m.	38.25	38.24	38.22	38.20	38.20	38.19	*38.17*	*38.17*	38.19	38.19	38.18	38.18	38.18	.....	38.26
		4 p. m.	38.25	38.23	38.21	38.20	38.19	38.18	*38.17*	38.19	38.19	38.19	38.18	38.18	*38.17*	.....	38.27
Pecan Point Place	429.1	8 a. m.	37.47	37.46	37.45	37.43	37.43	37.42	*37.41*	*37.41*	37.43	37.42	37.42	37.42	*37.41*	37.43	37.49
		4 p. m.	37.47	37.45	37.44	37.43	37.42	37.42	*37.41*	37.42	37.42	37.42	37.42	*37.41*	*37.41*	37.45	37.51

Willow Point Place	436.8	8 a. m.	37.06	37.07	37.06	37.05	37.04	37.03	37.02	*37.01*	37.02	37.03	37.02	37.02	37.02	37.03	37.10
		4 p. m.	37.06	37.07	37.06	37.05	37.04	37.03	*37.01*	*37.01*	37.03	37.03	37.02	37.02	37.02	37.05	37.09
Cottage Home	441.9	8 a. m.	36.72	36.71	36.70	36.68	36.68	36.67	36.64	36.62	36.67	36.67	36.66	36.65	36.65	36.65	36.78
		4 p. m.	36.71	36.70	36.69	36.68	36.68	36.66	36.63	*36.61*	36.67	36.67	36.65	36.65	36.65	36.69	36.78
Coushatta	448.4	8 a. m.	35.70	35.67	35.64	35.60	35.56	35.54	35.53	35.52	35.51	35.51	*35.49*	35.50	35.50	35.53	35.58
		4 p. m.	35.69	35.66	35.63	35.58	35.55	35.54	35.52	35.52	35.51	35.50	*35.49*	35.50	35.51	35.54	35.60
Viva Landing	458.0	8 a. m.	34.54	34.53	34.52	34.51	34.50	34.49	*34.48*	*34.48*	34.51	34.49	34.49	34.49	*34.48*	*34.48*	34.55
		4 p. m.	34.54	34.53	34.52	34.50	34.50	34.49	*34.48*	*34.48*	34.49	34.50	34.49	*34.48*	*34.48*	34.49	34.55
Kenilworth Place	462.0	8 a. m.	34.08	34.06	34.05	34.03	34.02	34.01	*34.00*	34.01	34.01	*34.00*	*34.00*	*34.00*	*34.00*	34.04	34.05
		4 p. m.	34.07	34.05	34.05	34.02	34.01	34.01	*34.00*	34.01	34.01	*34.00*	*34.00*	*34.00*	*34.00*	34.04	34.05
Brownville Place	‡470.7	8 a. m.	33.45	33.44	33.44	33.43	33.42	33.42	33.42	*33.41*	*33.41*	33.42	*33.41*	*33.41*	33.42	33.43	33.48
	472.2	4 p. m.															
Lake Poule d'Eau	§481.5	8 a. m.	33.08	33.07	33.06	33.05	33.04	33.04	*33.03*	*33.03*	33.05	33.04	*33.03*	*33.03*	*33.03*	*33.03*	33.10
	482.9	4 p. m.	33.08	33.07	33.06	33.05	33.04	33.04	*33.03*	33.04	33.05	33.04	*33.03*	*33.03*	*33.03*	*33.03*	33.10
Le Compte Bluff	490.1	8 a. m.	32.78	32.77	32.77	32.76	32.75	32.75	32.75	32.74	32.76	32.75	32.74	32.74	32.74	*32.73*	32.79
		4 p. m.	32.77	32.77	32.76	32.76	32.75	32.75	32.74	32.75	32.76	32.76	32.74	32.74	32.74	*32.73*	32.79
J. C. Henry Place	498.5	8 a. m.	30.89	30.88	30.86	30.85	30.85	*30.84*	30.85	30.85	30.86	30.86	30.85	*30.84*	*30.84*	*30.84*	30.92
		4 p. m.	30.89	30.87	30.86	30.85	30.85	*30.84*	30.85	30.85	30.86	30.86	30.85	*30.84*	*30.84*	30.86	30.92
Hyams Place	‖507.2	8 a. m.															
	509.0	4 p. m.												†29.83			
Willow Place	516.9	8 a. m.	29.18	29.17	29.16	29.13	29.12	29.11	29.08	29.07	29.05	*29.04*	*29.04*	*29.04*	*29.04*	*29.04*	29.14
		4 p. m.	29.18	29.17	29.15	29.13	29.12	29.09	29.08	29.07	29.05	*29.04*	*29.04*	*29.04*	*29.04*	29.09	29.14
Tessier Landing	526.7	8 a. m.	28.38	28.35	28.33	28.32	28.31	28.30	*28.28*	28.29	28.31	28.32	28.31	28.30	28.31	28.31	28.42
		4 p. m.	28.37	28.35	28.33	28.31	28.31	28.30	28.29	28.30	28.32	28.32	28.30	28.30	28.31	28.31	28.45
St. Maurice	537.8	8 a. m.	27.11	27.10	27.10	27.09	27.09	27.08	27.07	*27.06*	27.09	27.09	27.08	27.08	27.08	27.09	27.21
		4 p. m.	27.11	27.10	27.10	27.09	27.09	27.08	27.07	27.07	27.09	27.09	27.08	27.08	27.08	27.09	27.26
O. K. Landing	547.3	8 a. m.	26.00	25.98	25.98	*25.97*	*25.97*	*25.97*	*25.97*	25.98	26.00	26.00	25.98	*25.97*	25.98	25.99	26.02
		4 p. m.	26.00	25.98	25.98	*25.97*	*25.97*	*25.97*	*25.97*	25.98	26.00	25.99	*25.97*	*25.97*	25.98	26.00	26.02
High Dio Place	554.3	8 a. m.	25.13	25.12	25.11	25.10	25.09	25.08	25.08	*25.06*	25.10	25.11	25.09	25.08	25.09	25.09	25.21
		4 p. m.	25.13	25.11	25.11	25.09	25.09	25.08	25.07	25.07	25.10	25.10	25.08	25.08	25.09	25.09	25.26
Bell Landing	564.7	8 a. m.	24.02	24.00	24.00	23.98	23.97	23.96	*23.95*	*23.95*	23.98	23.99	23.97	23.96	23.97	23.98	24.14
		4 p. m.	24.01	24.00	23.98	23.97	23.97	23.96	*23.95*	*23.95*	23.99	23.99	23.96	23.96	23.97	23.98	24.14
St. Andre Bluff	574.9	8 a. m.	23.23	23.22	23.20	23.20	23.18	*23.17*	*23.17*	*23.17*	23.19	23.20	23.19	*23.17*	23.18	23.18	23.18
		4 p. m.	23.22	23.21	23.20	23.19	*23.17*	*23.17*	*23.17*	*23.17*	23.19	23.20	23.18	23.18	23.18	23.18	23.32
Colfax	585.8	8 a. m.	22.20	22.18	22.17	22.16	22.15	22.14	*22.13*	*22.13*	22.14	22.15	22.15	22.17	22.19	22.25	22.32
		4 p. m.	22.19	22.18	22.17	22.16	22.15	22.14	*22.13*	*22.13*	22.14	22.15	22.16	22.18	22.20	22.28	22.39
M. E. Landing	593.5	8 a. m.	21.74	21.73	21.73	21.72	21.69	21.68	*21.67*	21.69	21.70	21.72	21.73	21.74	21.75	21.76	21.82
		4 p. m.	21.74	21.72	21.73	21.71	21.69	21.68	21.68	21.70	21.71	21.73	21.74	21.75	21.74	21.78	21.86
Fairmount Place	600.8	8 a. m.	21.09	21.06	21.05	21.04	21.03	21.02	21.01	*21.00*	21.03	21.06	21.09	21.09	21.10	21.08	21.21
		4 p. m.	21.08	21.05	21.05	21.04	21.03	21.01	*21.00*	21.01	21.04	21.07	21.09	21.09	21.09	21.08	21.25
Lower Flagland Place	608.9	8 a. m.	20.81	20.79	20.78	20.78	20.76	20.75	20.74	20.74	20.74	20.76	20.79	20.80	20.81	20.81	20.90
		4 p. m.	20.80	20.78	20.78	20.76	20.75	20.75	20.74	*20.73*	20.75	20.78	20.80	20.80	20.82	20.81	20.94
Belleview Place	617.0	8 a. m.	20.55	20.53	20.52	20.51	20.50	20.49	*20.48*	*20.48*	20.51	20.53	20.55	20.55	20.56	20.55	20.67
		4 p. m.	20.54	20.52	20.52	20.51	20.50	20.49	*20.48*	*20.48*	20.51	20.54	20.55	20.54	20.56	20.55	20.70
China Grove Place	626.4	8 a. m.	20.40	20.38	20.37	20.37	20.35	20.34	20.34	*20.33*	20.34	20.37	20.39	20.40	20.41	20.40	20.51
		4 p. m.	20.39	20.37	20.37	20.36	20.35	20.34	20.34	*20.33*	20.35	20.37	20.39	20.40	20.41	20.40	20.53
400 meters above Houston, Central Arkansas and Northern Railroad Bridge.	637.5	8 a. m.	19.63	19.61	19.60	19.59	19.58	19.58	*19.56*	19.57	19.58	19.60	19.62	19.63	19.65	19.63	19.80
		4 p. m.	19.62	19.60	19.60	19.59	19.58	19.57	*19.56*	19.57	19.58	19.61	19.62	19.63	19.65	19.64	19.84

* Measured through Ferguson Cut-off, Arkansas (December 23, 1892).
† Interpolated.
‡ Measured through Lake End Point Cut-off, Louisiana.
§ Measured through Upper Brazil Place Cut-off, Louisiana.
‖ Measured through Le Vassar Cut-off, Louisiana.

TABLE 2.—*Water surfaces during low water on Red River in Arkansas and Louisiana*—Continued.

Place.	Distance.	Time.	November.					December.									
			26	27	28	29	30	1	2	3	4	5	6	7	8	9	10
LOUISIANA—continued.	*Kilos.*																
Alexandria	640.8	8 a. m.	19.03	19.01	19.00	19.00	19.00	18.98	*18.97*	*18.97*	18.98	19.00	19.01	19.01	19.04	19.07	19.19
		4 p. m.	19.03	19.01	19.00	19.00	19.00	18.98	*18.97*	*18.97*	18.98	19.01	19.01	19.01	19.06	19.10	19.22
Cut-off Place	648.3	8 a. m.	18.05	18.03	18.01	17.99	17.98	17.98	*17.97*	*17.97*	17.99	18.00	18.02	18.04	18.08	18.05	18.20
		4 p. m.	18.05	18.02	18.00	17.99	17.98	17.98	*17.97*	*17.97*	18.00	18.00	18.03	18.05	18.09	18.08	18.26
Hathorn Place	657.2	8 a. m.	17.67	17.65	17.63	17.62	17.60	17.60	17.59	*17.58*	17.61	17.62	17.64	17.65	17.71	17.67	17.82
		4 p. m.	17.66	17.64	17.62	17.61	17.60	17.59	*17.58*	*17.58*	17.61	17.62	17.65	17.67	17.69	17.69	17.87
Hortensia Place	666.0	8 a. m.	17.37	17.36	17.34	17.34	17.32	17.31	17.31	*17.28*	17.31	17.33	17.34	17.36	17.40	17.39	17.49
		4 p. m.	17.36	17.35	17.34	17.33	17.32	17.31	17.30	*17.28*	17.32	17.33	17.35	17.37	17.40	17.41	17.56
Casa Landing	673.6	8 a. m.	17.11	17.10	17.08	17.07	17.06	17.05	*17.04*	*17.04*	17.07	17.06	17.08	17.09	17.14	17.12	17.22
		4 p. m.	17.11	17.09	17.08	17.07	17.06	17.05	*17.04*	*17.04*	17.07	17.06	17.08	17.09	17.14	17.15	17.26
Grimes Bluff	681.5	8 a. m.	16.85	16.83	16.81	16.80	*16.78*	16.79	16.79	16.79	16.81	16.80	16.81	16.83	16.87	16.85	16.94
		4 p. m.	16.84	16.82	16.80	16.79	16.79	16.79	16.79	16.79	16.81	16.80	16.82	16.84	16.86	16.89	17.00
Egg Bend	690.3	8 a. m.	16.60	16.59	16.58	16.57	16.56	16.55	.....	*16.54*	16.57	16.57	16.56	16.55	16.61	16.64	16.73
		4 p. m.	16.60	16.59	16.58	16.56	16.55	16.55	16.55	*16.54*	16.58	16.57	16.56	16.55	16.63	16.65	.....
Cassandria	699.3	8 a. m.	.....	.....	.....	.....	.....	.....	*16.46*	*16.46*	16.47	16.47	16.47	16.48	16.53	16.51	16.60
		4 p. m.	16.52	.....	.....	.....	.....	.....	*16.46*	*16.46*	16.47	16.47	16.48	16.48	16.53	16.53	16.62
Danzat Place	705.8	8 a. m.	.....	.....	.....	.....	14.99	.....	*14.98*	.....	.....	.....	.....	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Normand Landing	716.9	8 a. m.	.....	.....	.....	.....	.....	14.19	14.20	*14.19*	14.21	14.20	14.20	14.23	14.27	14.27	14.38
		4 p. m.	.....	.....	.....	.....	.....	14.21	14.20	*14.19*	14.20	14.20	14.21	14.23	14.28	14.30	14.42
Ware Landing	722.0	8 a. m.	.....	.....	.....	.....	.....	.....	13.33	*13.32*	13.37	13.35	13.35	13.37	13.44	13.44	13.56
		4 p. m.	.....	.....	.....	.....	.....	13.34	13.33	*13.32*	13.36	13.35	13.36	13.37	13.45	13.47	13.58
Brouillette Landing	728.8	8 a. m.	.....	.....	.....	.....	.....	.....	.....	* *12.89*	12.94	12.94	12.93	12.95	13.02	13.02	13.11
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	12.95	12.93	12.94	12.95	13.03	13.05	13.14
Saline Bayou	737.8	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.91	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	* *11.77*	11.81	.....	.....	.....	.....	.....	.....
Double Eddy	742.4	8 a. m.	.....	.....	.....	.....	.....	.....	.....	* *11.60*	.....	11.63	11.64	11.65	11.75	11.79	11.86
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.64	11.64	11.66	11.79	11.79	11.89
Murry Place	750.1	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.25	11.28	11.37	11.38	11.47
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	* *11.22*	.....	11.25	11.27	11.29	11.45	11.40	11.54
Old Harris Place	760.1	8 a. m.	.....	.....	.....	.....	.....	.....	.....	* *10.08*	.....	.....	10.11	.....	.....	.....	.....
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Little Larto	765.5	8 a. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.93	9.01	9.05	9.26
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	* *8.87*	.....	.....	8.91	8.95	9.03	9.07	.....
Black River	774.0	8 a. m.	.....	.....	.....	.....	.....	.....	.....	* *7.42*	.....	.....	.....	7.47	7.53	7.57	7.73
		4 p. m.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.48	7.55	7.61	7.83
Barbre Landing	818.2	8 a. m.	6.88	6.88	6.89	6.88	6.87	6.89	6.90	6.92	6.90	6.88	6.92	6.85	6.93	6.98	7.13
		4 p. m.	6.88	6.90	6.89	6.88	6.88	6.90	6.91	6.91	6.89	6.87	6.86	6.88	6.96	7.03	7.22

* Interpolated.

TABLE 3.—*Discharge observations in Red River and tributaries (current meter).*

Locality.	Distance from Fulton, Ark.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface, Cairo datum.	Stage above low water, 1894.	Fall in water surface per hour for the previous 24 hours.
	Kilos.		*Square meters.*	*Meters.*	*Cubic meters.*	*Meters.*	*Meters.*	*Mms.*
Above Sulphur River, Ark	172.1	Sept. 24, 1894	109	0.66	61	64.05	0.70	1.67
Sulphur River (tributary)	172.7	....do....	54	0.19	9	64.01	0.70	1.67
Shreveport, La	303.5	Oct. 8, 1894	125	0.94	100	47.98	0.57	1.25
Above Alexandria, La	639.4	Nov. 19, 1894	259	0.44	89	19.38	0.17	1.25

TABLE 4.—*Summary of borings in bed of Red River between Fulton, Ark., and Atchafalaya River, Louisiana.*

[Wilson Bend, Arkansas, 6.1 kilometers from Fulton, Ark. Elevation, 79.1 meters, Cairo datum; site on sand bar (right bank), 1.7 meters above water surface.]

Elevation, down to—	Diameter of material.																	
	Dust to 0.2 millimeter.			0.2 to 0.5 millimeter.			0.5 to 1 millimeter.			1 to 1.5 millimeters.			1.5 to 2 millimeters.			2 to 38.1 millimeters.		
	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.
71.10...	65.2	2.62	Red gray sand.	34.5	2.64	Red gray sand *a*	0.12	.....	Coal and dirt..	0.04	.....	Coal and dirt...	.....	.....	.....	.....	.....	

[Henry Topp Place, Arkansas, 51.2 kilometers from Fulton, Ark. Elevation, 73.27 meters, Cairo datum; site on sand bar (right bank), 0.75 meter above water surface.]

71.10...	16.1	2.42	Red sand and silt.	56.2	2.61	Reddish sand..	15.8	2.62	Coarse sand....	3.4	2.52	Gravel and wood.	1.0	.....	Gravel and wood.	6.3	2.59	Gravel and wood.
69.55...	10.2	2.46	.....do.....	79.5	2.63	Yellowish sand and wood.	4.7	2.51	Coarse gray sand & wood.	1.2	.....	Gravel *b*	0.6	.....	Gravel *b*	2.2	2.58	Gravel.
67.14...	21.7	2.54	Red sand	67.7	2.58	Course yellowish sand.	1.6	2.50	Coarse yellowish sand.	0.4	.....	Gravel (quartz)	0.02	.....	Gravel (quartz)	0.32	...	Do.
66.24...	45.1	2.60	.....do.....	53.4	2.65	Red sand and trash.	0.3	.....	Trash.....	0.1	.....	Trash.....	0.1	.....	Trash.....	0.3	.....	Gravel and trash.
65.34...	49.7	2.51	Sand and silt..	44.4	2.52	Sand and clay..	3.5	2.48	Coarse sand and clay lumps.	0.3	.....	Gravel and clay lumps.	0.1	.....	Gravel.....	0.7	.....	Gravel.

[Avery Place, Arkansas, 88.8 kilometers from Fulton, Ark. Elevation, 70.07 meters, Cairo datum; site at head of island, sand bar (left bank), on range 189, 0.31 meter above water surface.]

67.09...	3.1	2.47	Red sand and silt.	15.8	2.61	Clean red sand.	17.0	2.61	Clean, coarse reddish sand.	9.4	2.63	Clean quartz gravel.	4.2	2.60	Clean quartz gravel.	49.2	....	Coarse gravel *c*.
66.51...	26.3	2.53	Red sand	23.4	2.53	Sand, clay lumps & wood fiber.	5.2	2.28	Coarse sand, clay lumps & wood.	3.9	2.26	Gravel, clay lumps & wood.	2.1	.....	Gravel, clay lumps & wood.	36.5	.....	Coarse gravel and wood *d*.
64.78...	14.5	2.45	.....do.....	43.1	2.61	Yellowish sand and trash.	18.1	2.66	Coarse sand and trash.	5.4	2.53	Gravel and trash.	2.0	2.45	Gravel.....	14.6	2.50	Gravel and wood.
63.87...	Material lost.....																	

[Avery Place, Arkansas, 88.8 kilometers from Fulton, Ark. Elevation, 68.16 meters, Cairo datum; site on range 189.40 meters from right water edge, 1.6 meters below water surface (channel).]

67.28...	17.6	2.63	Clean yellow sand.	81.1	2.66	Clean yellow sand.	0.2	.....	Clean sand.....	0.1	.....	Clean gravel...	.....	.....	.....	.....	.....		
66.16...	28.8	2.59	Yellow sand...	70.7	2.68	.....do.....	.....	.....	Sand and trash.	.....	.....	.....	.....	.....	.....	.....	.....		

[California Place, Arkansas, 131.9 kilometers from Fulton, Ark. Elevation, 67.02 meters, Cairo datum; site on sand bar (left bank), 0.51 meter above water surface.]

64.05...	99.7	2.58	Reddish sand..	0.3	.....	Coal and trash.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
62.23...	99.5	2.63	Red sand	0.4	.....	Sand, coal and trash.	0.1	.....	Coal and trash.	.....	.....	Coal and trash.	.....	.....	.....	.....	.....		
61.09...	48.7	2.58	Reddish sand..	49.3	2.65	Red gray sand.	1.1	.....	Red gray sand.	0.2	.....	Sand.....	0.1	.....	Gravel.....	0.1	.....	Gravel.	

[California Place, Arkansas, 131.9 kilometers from Fulton, Ark. Elevation, 65.41 meters, Cairo datum; site, 40 meters from left water edge, 1.1 meters below water surface (channel).]

63.41...	28.8	2.62	Red gray sand.	70.3	2.64	Red gray sand.	0.1	.....	Sand.....	.....	.....	.....	.....	.....	.....	.....	.....		

[Head of Tones Bayou, Louisiana, 332.7 kilometers from Fulton, Ark. Elevation, 47.63 meters, Cairo datum; site on sand bar (left bank) 0.49 meter above water surface.]

41.81...	20.2	2.62	Reddish sand..	67.0	2.61	Yellow brown sand.	9.7	2.69	Dirty brown and black sand.	1.3	.....	Coarse rounded sand.	0.4	.....	Rounded gravel	0.7	.....	Rounded gravel.	

[Elder Grove Place, Louisiana, 421.7 kilometers from Fulton, Ark. Elevation, 38.41 meters, Cairo datum; site on sand bar (left bank) 0.11 meter above water surface.]

35.41...	41.2	2.67	Yellow sand...	58.1	2.73	Yellow and gray sand.	0.1	.....	Sand, coal, and trash.	.....	.....	.....	.....	.....	.....	.....	.....		
34.65...	51.6	2.55	.....do.....	44.0	2.58	Gray and yellow sand.	0.2	.....	Sand and trash.	0.1	.....	Rounded gravel	0.1	.....	Rounded gravel	3.7	2.56	Large rounded gravel.	
32.23...	28.9	2.55	Red yellow sand	70.6	2.61	Yellow gray sand.	0.3	.....	Sand	0.1	.....	Sand and gravel	.....	.....	.....	.....	.....		

a Small per cent of coal.
b Small per cent of wood.
c Largest piece, 610½ grains; 4 pieces quartz, 98 grains, 2.69 specific gravity; 1 piece sandstone, 102⅛ grains, 2.63 specific gravity.
d Thirty-four pieces quartz, 75 grains, 2.68 specific gravity; 1 piece quartz, 77⅛ grains, 2.58 specific gravity; 1 piece quartz, 68⅛ grains, 2.58 specific gravity.

TABLE 4.—*Summary of borings in bed of Red River between Fulton, Ark., and Atchafalaya River, Louisiana*—Continued.

[Coushatta, Louisiana, 448 kilometers from Fulton, Ark. Elevation, 36.09 meters, Cairo datum; site on sand bar (left bank) 0.17 meter above water surface.]

Elevation, down to—	Diameter of material.																	
	Dust to 0.2 millimeter.			0.2 to 0.5 millimeter.			0.5 to 1 millimeter.			1 to 1.5 millimeters.			1.5 to 2 millimeters.			2 to 38.1 millimeters.		
	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.
33.09...	47.4	2.48	Reddish sand..	50.4	2.61	Gray sand.....	1.4	.....	Gray sand.....	0.1	.....	Sand.....	0.1	.....	Gravel.....	0.1	.....	Gravel.
32.02...	43.1	2.60	Red gray sand.	51.2	2.59	Yellow gray sand.	3.4	.....	Dirty yellowish sand.	0.5	.....	Rounded sand.	0.2	.....	Rounded gravel	0.6	.....	Rounded gravel
30.09...	15.4	2.53	Reddish sand..	72.7	2.62	Yellow sand...	6.1	2.58	Dark yellowish sand.	0.8	.....	Dark, dirty sand.	0.3	.....	.....	4.6	2.61	Large rounded gravel.

[Coushatta, Louisiana, 448 kilometers from Fulton, Ark. Elevation, 33.92 meters, Cairo datum; site on range 322, 38 meters from left water edge (channel) 2 meters below water surface.]

33.73...	55.2	2.16	Red clay.....	37.7	2.15	Red clay.....	2.5	.....	Red clay lumps	0.1	.....	Red clay lumps	.....	.....	.....	.....	.....	
32.29...	47.7	2.59	Reddish sand..	49.1	2.59	Red gray sand.	1.7	2.52	Red gray sand.	0.4	.....	Gravel	0.2	.....	Gravel.....	0.3	.....	Gravel.
31.92...	70.7	2.42	Red clay lumps and sand.	24.2	2.50	Red clay lumps	1.3	.....	Red clay lumps	1.3	.....	Red clay lumps	.....	.....	.....	.....	.....	

[Dixie Bar, Louisiana, 454.4 kilometers from Fulton, Ark. Elevation, 36.7 meters, Cairo datum; site on range 14, left water edge, equal water surface.]

36.1....	91.8	2.78	Dark red sandy clay.	7.7	2.33	Red brown sand and clay.	0.3	.....	Sand, dirt, and grit.	0.1	.....	Grit	.....	.....	.....	.....	.....	
34.4....	85.7	2.58	Reddish gray sandy clay.	13.8	2.66	.....do.....	0.1	.....	Dirt	0.1	.....	Dirt	.....	.....	.....	.....	.....	
33.3....	60.8	2.34	Dark red sandy clay.	33.6	2.50	Red brown clay. a	2.4	.....	Dirt (red clay)..	0.6	.....	Dirt (red clay)..	.....	.....	.....	.....	.....	
31.1....	66.3	2.61	Red yellow sand	33.2	2.66	Red yellow sand	0.1	.....	Sand	.....	.....	.....	.....	.....	.....	.....	.....	

[Dixie Bar, Louisiana, 454.4 kilometers from Fulton, Ark. Elevation, 35.1 meters, Cairo datum; site on range 14, 30 meters from left water edge (channel).]

32.5	93.6	2.50	Dark red brown sandy clay.	5.8	2.44	Sand and dirt (brown red).	0.2	.....	Dirt, sand, and clay.	0.1	.....	Dirt	.....	.....	.....	.....	.....	
31.5	64.2	2.72	Red brown sandy clay.	33.3	2.73	Red brown sand	0.2	.....	Red gray sand (some wood).	0.1	.....	Coarse sand ...	.....	.....	.....	.....	.....	

[Dixie Bar, Louisiana, 454.4 kilometers from Fulton, Ark. Elevation, 34.9 meters, Cairo datum; site on range 14, 30 meters from right water edge (channel).]

32.1	56.9	2.33	Red gray sand.	42.9	2.53	Red gray sand.	0.1	.....	Dirt	.....	.....	Dirt	.....	.....	.....	.....	.....	
31.0	78.3	2.62	Bright red brown sandy clay.	18.9	2.46	Red brown clay	0.8	.....	Red clay.....	0.1	.....	.....do.....	.....	.....	.....	.....	.....	

[Dixie Bar, Louisiana, 454.4 kilometers from Fulton, Ark. Elevation, 36.7 meters, Cairo datum; site on range 14, right water edge, equal water surface.]

35.0	93.3	2.48	Red brown sandy clay.	5.3	2.34	Brown clay[a]...	0.7	.....	Brown clay....	0.1	.....	Dirt	.....	.....	.....	.....	.....	
33.1	95.5	2.48	.....do.....	3.1	.....	.....do.[a].....	0.7	.....	Red brown clay	0.1	.....	.....do.....	.....	.....	.....	.....	.....	
31.3	44.5	2.15	Red gray sand.	54.8	2.68	Yellow gray sand.	0.1	.....	Sand and clay..	.....	.....	.....	.....	.....	.....	.....	.....	

[O. K. Bar, Louisiana, 547.3 kilometers from Fulton, Ark. Elevation, 26.76 meters, Cairo datum; site on range 109, left water edge, equal water surface.]

21.9	46.6	2.54	Red yellow sand	38.2	2.60	Yellow sand...	7.8	2.60	Yellow sand...	1.2	.....	Sand.....	0.4	.....	Gravel.....	5.1	.....	Gravel.[b]
21.3	41.8	2.40	Red sandy clay.	32.1	2.54	Gray yellow sand.	11.3	2.55	Gray yellow sand.	5.1	.....	Wood & gravel.	2.8	.....	Wood & gravel.	6.0	2.57	Wood & gravel.
19.84	60.9	2.34	Gray sandy clay	24.9	2.59	Gray sand.....	4.6	2.58	Gray sand.....	1.0	.....	Sand.....	0.7	.....	Gravel.....	7.3	2.61	Large gravel.

[a] Small per cent of sand.
[b] 1 piece rock, 240 grains, 2.61 specific gravity; 1 piece gravel, 147 grains, 2.60 specific gravity.

TABLE 4.—*Summary of borings in bed of Red River between Fulton, Ark., and Atchafalaya River, Louisiana*—Continued.

[O. K. Bar, Louisiana, 549 kilometers from Fulton, Ark. Elevation, 26.4 meters, Cairo datum; site on range 111, left water edge, equal water surface.]

Elevation, down to—	Diameter of material.																	
	Dust to 0.2 millimeter.			0.2 to 0.5 millimeter.			0.5 to 1 millimeter.			1 to 1.5 millimeters.			1.5 to 2 millimeters.			2 to 38.1 millimeters.		
	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.
25.0	85.0	2.54	Red sandy clay.	14.4	2.51	Red gray sand.	0.5	.....	Coal and dirt..	0.1	.....	Coal and dirt..	.....	.....	.....	.....	.....	.....
22.2	19.6	2.56	Red yellow sand	73.4	2.60	Yellow gray sand.	5.0	2.61	Sand.	0.6	2.51	Sand.....	0.2	2.51	Gravel.....	0.5	2.40	Coal & gravel. *a*
21.5	38.6	2.59	Red gray sand and clay.	51.6	2.64	.....do.....	6.7	.....	Wood and sand.	1.1	.....	Wood, gravel, and coal.	0.3	.....	Wood & gravel.	0.6	.....	Wood & gravel.
20.8	30.5	2.47	Red brown sandy clay.	65.8	2.59	.....do.....	2.0	.....	Sand.....	0.3	.....	Sand and coal..	0.1	.....	Gravel.....	0.1	.....	Gravel (three pieces).
20.1	74.1	2.15	Dark gray clay.	23.4	2.19	Dark gray clay.	2.2	.....	Dirt *b*.....	0.3	.....	Gravel and dirt.	.....	.....	.....	.....	.....	

[O. K. Bar, Louisiana, 549 kilometers from Fulton, Ark. Elevation, 25 meters, Cairo datum; site on range 111, 50 meters from left water edge (channel).]

21.0	33.6	2.60	Red gray sand.	53.1	2.58	Dark yellowish sand.	9.2	2.64	Dark yellowish sand.	1.7	2.62	Well-worn gravel.	0.7	2.62	Well-worn gravel.	1.2	2.68	Well-worn gravel.

[O. K. Bar, Louisiana, 549 kilometers from Fulton, Ark. Elevation, 25.9 meters, Cairo datum; site on range 111, 150 meters from left water edge (channel).]

21.6	13.7	2.57	Bright yellow sand.	82.9	2.63	Bright yellow sand.	2.0	2.66	Yellow sand...	0.2	.....	Sand.....	0.1	.....	Gravel.....	1.0	.....	Large gravel. *c*

[O. K. Bar, Louisiana, 549 kilometers from Fulton, Ark. Elevation, 26.4 meters, Cairo datum; site on range 111, right water edge, equal water surface.]

20.9	24.7	2.31	Yellow sand...	65.9	2.54	Red gray sand.	7.2	2.64	Red gray sand.	1.0	.....	Coarse sand....	0.3	.....	Gravel.....	1.3	.....	Large gravel.
20.2	72.4	2.14	Blue clay.....	25.8	2.22	Blue clay.....	1.8	.....	Blue clay.....	.....	.....	.....	.....	.....	.....	.....	.....	

[Alexandria, La., 640.9 kilometers from Fulton, Ark. Elevation, 19.31 meters, Cairo datum; site on range 197, right water edge, equal water surface.]

18.57...	78.8	2.22	Red clay.....	19.0	2.32	Red gray clay..	1.4	.....	Dirt	0.3	.....	Slate and dirt.	.....	.....	.....	.....	.....	.....	
15.91...	13.7	2.53	Yellow sand....	80.4	2.64	Gray yellow sand.	0.9	.....	Gray sand.....	0.2	.....	Sand.....	0.1	.....	Gravel.....	3.6	2.64	Large gravel.	
15.47...	19.1	2.21	Red clay.....	65.2	2.51	Red brown sand and clay.	4.5	.....	Sand and dirt..	0.9	.....	.....do.....	0.3	.....	.....do.....	9.9	2.54	Do.	

[Alexandria, La., 640.9 kilometers from Fulton, Ark. Elevation, 18.1 meters, Cairo datum; site on range 197, 20 meters from right water edge (channel).]

13.46..	13.7	2.54	Gray yellow sand.	62.7	2.60	Yellow sand...	10.7	2.56	Yellow sand...	2.2	.....	Sand and dirt..	0.7	.....	Gravel and small pieces of glass.	9.4	2.46	Gravel and small pieces of glass.	

[Alexandria, La., 640.9 kilometers from Fulton, Ark. Elevation, 18.53 meters, Cairo datum; site on range 197, 50 meters from right water edge (channel).]

14.89...	17.5	2.57	Yellow sand...	67.8	2.62	Yellow and gray sand.	8.5	2.62	Yellow sand...	2.2	.....	Gravel *d*	0.8	.....	Gravel *d*	2.5	.....	Gravel & wood.	
14.30...	98.4	2.39	Red brown clay	1.6	.....	Red clay.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		

[Alexandria, La., 640.9 kilometers from Fulton, Ark. Elevation, 18.66 meters, Cairo datum; site on range 197, 75 meters from right water edge (channel).]

14.84...	31.5	2.59	Yellow sand...	65.9	2.62	Yellow sand...	1.6	.....	Sand.....	0.2	.....	Sand.....	0.1	.....	Gravel.....	0.1	.....	Gravel.	

[Alexandria, La., 640.9 kilometers from Fulton, Ark. Elevation, 18.27 meters, Cairo datum; site on range 197, 125 meters from right water edge (channel).]

13.60...	34.2	2.38	Yellow sand...	65.3	2.54	Yellow sand...	0.1	.....	Sand and trash.	.....	.....	.....	.....	.....	.....	.....	.....		

a 1 piece gravel, 6½ grains, 2.60 specific gravity.
b Small per cent of sand.
c 1 piece gravel, 39 grains, 2.50 specific gravity.
d Small per cent of wood.

GENERAL REMARKS.

Details of levee construction already have been given, but they convey only a small notion of the amount of work that has been accomplished with comparatively small means.

While the United States work is intended as part of a system to improve navigation, that of the State engineers and levee boards is for direct protection of the fertile lands from overflow. The allotments from the appropriations for improving Red River represent only a small percentage of the cost of this work, but they have served to direct the action of the State engineers to no small degree in planning their portions of the system. It is pleasant to repeat that the greatest harmony exists between this office and the State engineers and levee boards; and if this work should be prosecuted in the same manner for a few years the whole system could be finished, at least within Caddo and Bossier levee districts, at a relatively very moderate charge to the United States. It is my opinion that our efforts should be specially directed to extending the line from Missionary downstream to meet the line now projected upstream from Red Bayou to Hervey Canal this season. The country is a very difficult one, and as the levee districts have about exhausted their means, until the cotton taxes shall begin to yield the necessary funds, the greater part of this work should fall upon the United States. Practical help should be given also by raising and enlarging State levees which were built at lower grade than desired, for lack of means, the engineers considering it better to close existing gaps and take certain risks as to flood heights and strength of section to leaving them open.

No assistance has been given by the United States to the district below Alexandria, and it is only fair that this should be done as early as possible for the benefit of the people who are thus contributing directly to the improvement of the lower river.

From one point of view, the long season of low water has been fortunate for the system, giving the newer levees time to consolidate and become well sodded, but on the other hand it has made people living behind them careless, and in many cases they have cut into the levees for road crossings. Filling and repair when a flood is imminent can not be regarded as anything short of inviting disaster. Appeals to parish police juries have not resulted in any marked degree of improvement, and therefore it is suggested that the matter be taken up by the United States more fully than in the general laws heretofore enacted in regard to injuring public works.

Closing outlets, which is a prerequisite to levee construction, has been going on slowly as recommended some twenty years ago by Captain (now Lieutenant-Colonel) Benyaurd, and the disasters predicted by those who were then opposed to such work, and especially by those who still try to present arguments in favor of outlets, have not taken place, and are not likely to occur. A levee may be topped here and there by some sudden flood if the river should happen to be obstructed by jams below, or if the levee were injured by cutting down for temporary crossing, or willfully cut, but since the bed continues to go down with the lowered low-water line, it is my opinion that accidents of the kind would be localized, and that Red River will increase its carrying power so as to provide ample channel way for its own discharge at the highest stages.

The subject of general improvement was discussed somewhat extensively in my last report (Report Chief of Engineers, 1894, p. 1430), and I can add nothing to it, except to repeat that the serious improvement

of navigation should be undertaken at an early date. The work is of such a kind that it can not be undertaken advantageously by contract, but must be done by hired labor and plant owned by the United States. A beginning certainly should be made, and considering all the conditions of distance, means of repair, etc., it should be of durable materials, hulls of steel, and certain parts as piledrivers and dredges self-propelling, to be independent of the snag boats or to avoid the necessity of building other steamboats. Makeshifts have been used in putting in temporary wing dams and dikes, but this method would not be economical for large operations.

The maps of the survey have been blue printed and are very useful, but it would be cheaper to print an edition, especially as the cost of printing a few sets on tracing linen, or transferring by means of celluloid films, as was done on the Cypress Bayou survey, would permit additions or changes to be noted. No more field work is required at present, except local examinations and gaugings, which should be continued. The item for repairs to plant will be larger this year than usual, as the *Howell* should have a new bottom of steel, and as prices appear to be rising the amount formerly estimated must be increased considerably, especially as the boat will have to go to New Orleans or St. Louis for the work.

ESTIMATES.

Additions to plant, dredges, pile drivers, barges, steamboats, tools, rigging, and outfit	$100,000
Care of plant, repairs, etc	30,000
Service of snag boats, dredges, and chopping parties	50,000
Closing outlets, sills, dredging for outlets for impounded water, draining lakes, etc	40,000
2,250,000 cubic yards levees	450,000
Fixing and revetting bends, caving banks, dikes, spurs, etc	300,000
Surveys, gauges, discharge measurements, maps, etc	20,000
Office charges, administration, transportation, etc	10,000
Total	1,000,000

The amounts expended during the year and balances unexpended July 1, 1895, are as follows:

Allotments.	Expended during year.	Balances July 1, 1895.
For general improvement, repairs, care of plant, etc	$17,404.20	$39,211.57
For Little River from Scopini Cut-off to Knox Point	727.56	12,999.85
For work at Alexandria	72.80	14,980.24
For survey of Red River	7,850.05	1,070.37
For construction of levees	39,531.64	54,511.41
For Sulphur River		5,000.00
Total	65,586.25	127,773.44

Money statement.

July 1, 1894, balance unexpended	$43,359.69
Amount appropriated by act of August 17, 1894	150,000.00
	193,359.69
June 30, 1895, amount expended during fiscal year	65,586.25
July 1, 1895, balance unexpended	127,773.44
July 1, 1895, outstanding liabilities	148.70
July 1, 1895, balance available	127,624.74
Amount that can be profitably expended in fiscal year ending June 30, 1897	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Red River was reported navigable for light boats the entire year from Shreveport, La., to Fulton, Ark. Between Shreveport and the mouth navigation was suspended by low water about four months (August to November). The lighter draft boats could run Little River from Shreveport to Knox Point (36 miles), the whole year. Below Montgomery navigation was uninterrupted. The mouth was open the entire year.

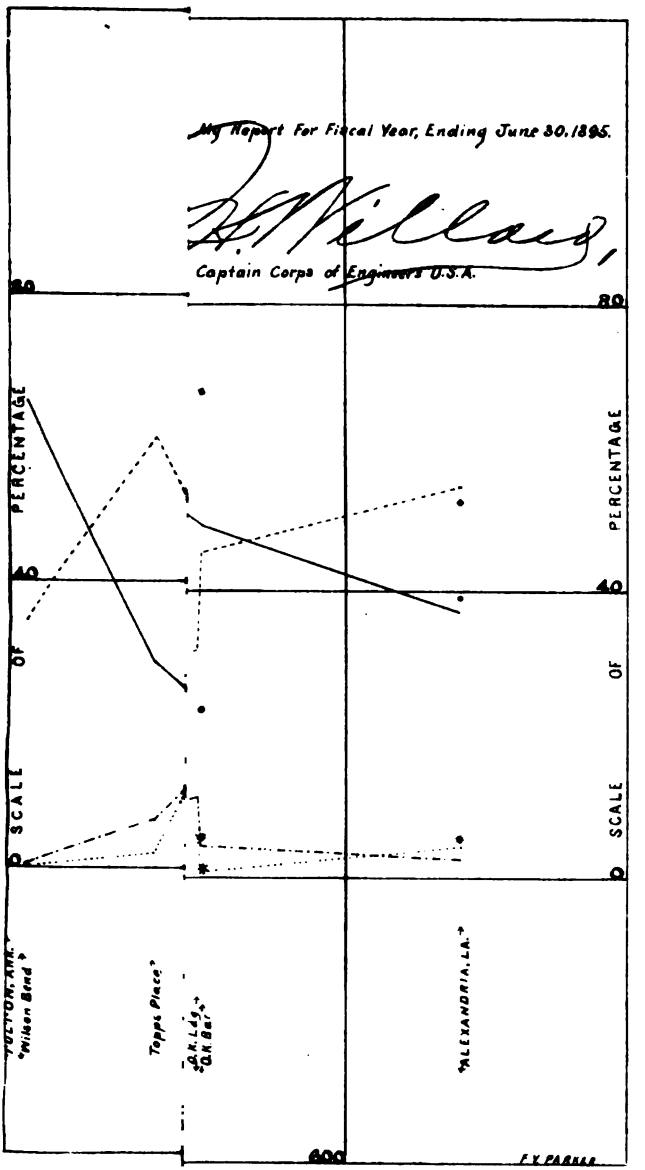
List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Valley Queen	Stern-wheel.	410.83	190.6	35.8	5.6	2 6	9 0	Shreveport and New Orleans, La.	10	190
Hallette	...do..	265.90	161.0	30.5	4.5	2 0	6 6	.....do.....	13	186
Rosa Bland	...do..	148.71	113.2	22.8	4.4	1 6	3 6	Shreveport, La., and Garland, Ark.	34	127
								Shreveport and Coushatta, La.	38	
E. P. Wheelock	...do..	254.49	160.0	30.0	4.9	1 8	5 6	New Orleans and Shreveport, La.	9	58
Nat F. Dortch	...do..	302.88	164.0	28.8	3.5	1 3	3 6	Shreveport and Alexandria, La.	1	.....
Anna B. Adams	...do..	315.49	157.0	31.6	3.1	1 6	4 6	New Orleans and points on Red River, La.	29	428
								Shreveport and points on Red River, La.	13	
								Shreveport, La., and Garland, Ark.	3	
Royal	...do..	44.82	86.6	24.0	3.0	1 2	3 0	Fulton and Garland, Ark.	77	.....
May Fisher (with barges).	...do..	52.84	92.0	18.8	4.0	3 0	.....	Baton Rouge and East Point, La.	2	.....
H. W. Graves (with barges).	...do..	31.22	94.6	17.6	3.0	1 2	3 0	Alexandria and Coushatta, La.	.....	.....
								Alexandria and Campti, La.	.....	.....
Imperial	...do..	494.69	210.0	40.6	6.6	2 6	9 0	New Orleans and Shreveport, La.	3	66
Joe Walker	...do..	45.00	80.0	20.0	3.0	0 10	3 0	Shreveport and Whitehall, La.	13	.....
								Shreveport and Elmer Bayou, La.	1	.....
Jennie Gilchrist (with barges).	...do..	74.48	105.5	18.5	3.8	.....	.....	Cairo, Ill., and Fulton, Ark.	1	.....
Ferd Herold	...do..	900.58	244.6	34.0	7.2	3 6	8 6	St. Louis, Mo., and Campti, La.	1	.....
Lillie (towboat)	...do..	61.42	120.0	26.0	3.5	2 6	3 6	New Orleans and Jonesville, La.	1	.....
Florence (with barges).	Tug..	18.49	56.1	12.0	5.6	3 0	.....	Shreveport, La., and Fulton, Ark.	.....	.....

During the year the steamers *E. B. Wheelock*, *Anna B. Adams*, *Nat F. Dortch*, and *Gamma* were sunk. The *Anna B. Adams* was raised. The *Dortch* was sunk twice.

Summary of commerce reported.

Articles.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.	1888-89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	18,308	15,392	14,061	29,400	21,613	18,838	12,593
Cotton seed	5,322	4,402	7,902	31,832	12,249	14,140	11,975
Cotton-seed meal	4,516	9,042	4,713	.....	10,000	.....	.....
Live stock	49	496	1,185	286	38	.....	32
Hides and skins	50	31	62	151	212	35	97
Lumber	1,657	1,257	1,520	2,352	.....	4,519	.....
Saw logs	20,000	28,869	15,200	22,250	16,523	.....	.....
Staves	697	228	1,739	206	81	58	.....
Stone	.....	.....	.....	.....	.....	.....	4,600
Miscellaneous	3,000	105,395	5,964	14,107	2,719	136	373
Total down freight	53,599	165,112	52,346	100,584	63,435	37,726	29,670
Return freight	22,122	63,518	17,605	19,942	30,051	28,650	19,780
Total	75,721	228,630	69,951	120,526	93,486	66,376	49,450
Estimated value	$3,419,000	$6,061,000	$3,422,000	$6,877,000	$9,185,000	$6,820,000	$5,370,000


My Report For Fiscal Year, Ending June 30, 1895.
H. M. Williams,
Captain Corps of Engineers U.S.A.
80
80
PERCENTAGE
PERCENTAGE
40
40
OF
OF
SCALE
SCALE
0
0
"PUCTON, ARK."
"Pilkin Bend"
Tapps Place"
"D.R. Lig"
"D.R. Bar"
"ALEXANDRIA, LA."
600
F.Y. PARKER

Eng 54 1

Not included in the above was 8,774 bales cotton received for shipment by river, but afterwards forwarded by rail, the low stage preventing boats reaching Shreveport in time to transport it.

In addition to the above, from Ouachita River entering Red River at mouth of Black River, 73,679 tons; the value of which is estimated at $3,293,000.

Receipts and shipments of bales of cotton at Shreveport, La.

	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
RECEIPTS.							
By rail	52,573	30,033	25,277	44,256	39,890	25,476	30,331
By wagon	54,968	41,014	31,612	49,644	37,725	40,026	35,450
By river	11,319	5,581	4,821	9,189	14,836	8,897	12,368
Warehouse receipts	118,860	76,628	61,710	103,089	92,451	74,399	78,149
SHIPMENTS.							
By Texas and Pacific Rwy	34,239	25,019	26,904	36,645	23,311	23,690	20,582
By Vicksburg, Shreveport and Pacific R. R.	20,239	10,546	10,384	23,251	15,564	20,813	24,029
By Houston and Shreveport R. R.	22,459	13,429	3,114	5,353	13,860	12,529	494
By St. Louis Southwestern Rwy	28,469	17,817	7,818	24,187	15,039	8,820	24,125
By river to New Orleans	10,654	9,246	14,751	10,567	19,218	8,412	8,956
Total	116,060	76,057	62,971	100,003	86,992	74,264	78,186

The competing routes of transportation for the trade of Red River Valley below Fulton, Ark., are as follows: The river is crossed by the St. Louis, Iron Mountain and Southern Railway at Fulton, Ark., by the St. Louis Southwestern Railway (Cotton Belt route) at Garland, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Shreveport, La., and a branch of the Cotton Belt system from Lewisville, Ark., 8 miles east of Garland, runs parallel to the river to Shreveport. The Texas and Pacific Railway runs nearly parallel to the river and touches at Alexandria, Boyce, Shreveport, and other points on the main river, and at Jefferson, Tex., on Cypress Bayou, and connects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain and Southern. Morgan's Louisiana and Texas Railroad, a branch of the Southern Pacific, runs from Alexandria to the main line. Shreveport is the eastern terminus of the Houston and Shreveport Railroad. The Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific system, crosses the river about 1¼ miles above Alexandria. The Kansas City, Watkins and Gulf Railway runs from Lake Charles, La., on the Southern Pacific, to Alexandria, and another line is projected that will cross at Alexandria. Jefferson, Tex., at the head of navigation of Cypress Bayou, has transportation by the Missouri, Kansas and Texas Railway, in addition to the Texas and Pacific Railway mentioned above. The Texarkana and Shreveport Railroad is built from Texarkana to Lynn, Ark., about 6 miles from the mouth of Sulphur River. The Texarkana and Fort Smith Railway and Kansas City, Pittsburg and Gulf Railroad, projected from Kansas City, Mo., to Sabine Pass, Tex., will touch Red River at Shreveport, La. An extension of the Sherman, Shreveport and Southern Railway is projected to run from Jefferson to Shreveport, about 50 miles, or from Jefferson to Waskom, Tex., about 30 miles.

U 2.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

An examination of Red River above Fulton, Ark., was made in 1884, in compliance with river and harbor act of that year, and the plan recommended for its improvement contemplated removing snags, drift, etc., to secure safer high-water navigation to the mouth of Kiamichi River, Indian Territory, about 138 miles above Fulton. The cost of the work was estimated at $10,000 if granted in a single appropriation. (Report Chief of Engineers, 1885, pp. 1617–1627.) In 1889 an additional

appropriation of $2,000 was asked for, to be applied to going over and completing the work. After the expenditure of this amount it was recommended that nothing further be done unless a single appropriation of not less than $10,000 be granted to allow the systematic clearing of the banks and removal of logs from the channel.

The appropriations have been as follows:

By act of—	
August 5, 1886	$7,000
August 11, 1888	3,000
September 19, 1890	2,000
July 13, 1892	3,500
August 17, 1894	3,500
Total	19,000

In the fiscal year 1887 the hand-propelled snag boat *Harry Breck*, fitted with steam capstan, was built at Fulton at a cost of $4,000 for use on this improvement. During the periods of low water in 1887 and 1888 this boat was employed in removing obstructions until the funds were exhausted, after which, in December, 1888, it was transferred for temporary use in Red River below Fulton. In February, 1891, the snag boat was sold to the work of improving Red River, Louisiana and Arkansas, for $1,500, and the proceeds of the sale were applied to removal of obstructions above Fulton, in connection with the appropriation of September 19, 1890. In January and February, 1891, the snag boats *Howell* and *Breck* were employed in going over the work, and operations of the former extended upstream to within 30 miles of the upper limit, as far as the boat was able to go on the stage of water, and a fair steamboat channel was cleared for navigation at high stages of water, practically completing the project for this improvement.

Under the act of 1892 the U. S. snag boat *C. W. Howell* worked over the river January 1 to March 11, 1893, operations extending from Fulton to the mouth of Kiamichi. The river was found to have scoured and improved considerably since the work done in 1891, and the *Howell* reached the upper limit at stages near extreme low water without much difficulty. Owing to the constant scour the majority of the obstructions encountered were removed with greater ease than when the previous work was done. The limited appropriation rendered any attempt to remove all obstructions impracticable, and operations were confined to clearing a safe channel for passage of the *Howell*. Judging from previous work the channel should have widened and scoured considerably, giving better and safer navigation at all stages, but since operations ceased there has been no means of inspecting the river at low water to determine what changes have occurred and the amount of drift contributed from the extensive woodlands above.

During the fiscal year ending June 30, 1895, operations were continued as follows:

There being no plant for this work the U. S. snag boat *C. W. Howell*, M. B. Lydon, master, was transferred for temporary service above Fulton during the period March 9–May 7, 1895. Supplies were taken aboard at Fulton Saturday, March 9, and Monday, March 11, work commenced above Fulton and was carried to the Texarkana and Fort Smith Railway Bridge, about 23 miles above, March 19. The river was at a low stage, and it was found impossible to pass above the bridge on account of a sand bar which had formed under the drawspan. As there was a heavy rain at the time a rise of the river was expected, and the crew was put to work removing stumps and logs from the bar to give safe passage for the snag boat. The river continued to fall, how-

ever, and the morning of March 20 the *Howell* turned back, rounding to at the mouth of Little River, 2 miles above Fulton, to work over the stretch below the bridge again, the stage being considerably lower than when the boat passed up early in the month, exposing numerous obstructions. For about 8 miles above Little River the snags were so firmly imbedded in the bottom of the river that many broke off in pulling, but wherever possible the stumps were blown out with dynamite. In the remainder of the stretch below the bridge the snags were got out, roots and all, without so much difficulty. This work was carried to the railway bridge April 10. The stage still being too low for the snag boat to pass that structure, temporary bateaux were built, and a chopping party with a supply of high explosives was sent to continue operations above the bridge. Work of this party was carried upstream to Spanish Bluff, Tex., about 42 miles above the bridge, or nearly midway between Fulton and the Kiamichi River, where it was suspended by a rise of the river May 2. The party returned to the *Howell* May 4, and steam was raised at once and work commenced by that vessel at the drawspan of the bridge with the expectation of being able to pass above, but on the morning of May 5 a fall set in, and, owing to the lateness of the season and the risk of the snag boat being caught and detained during a period of extreme low water, the boat started downstream and passed below Fulton the morning of May 8.

The following is a summary of the work done by the *Howell* and the chopping party March 9 to May 7, 1895, viz:

Distance worked over (estimated)	miles..	65
Snags removed from channel		2,268
Stumps removed from channel		153
Shore snags cut		886
Logs removed from channel		416
Leaning trees cut		168
Old piles removed at Fulton Bridge		8

April 24, 1895, the general manager of the Texarkana and Fort Smith Railway was notified by me to take prompt measures to open and maintain the channel through the drawspan of the bridge north of Texarkana, and May 30 the master of the snag boat *Howell* was sent to the bridge to see if this had been done. He reported that the railway company had made every effort to open a channel through the bar, having constructed a pile driver and built a pile dike about 400 feet in length, with a spur of 100 feet at the outer end, which will force the channel through the draw as soon as there is sufficient volume of water to cover and cut the sand bar. At the time this inspection was made the bar was cutting slowly, but the stage of river was too low to give effective force to the dike.

The commerce and navigation of Red River above Fulton as yet are so limited that it is not believed that any extensive improvement is required at present, and the recommendation made in my report of 1891 and repeated each year since remains applicable, viz:

This part of the river is navigable for the smallest boats, and during high stages only. Lanesport, Ark., near the Indian Territory line, 74 miles above Fulton, usually is considered the upper limit of navigation, but boats make occasional trips to Kiamichi on the highest stages of river. Below the Kiamichi Red River has no tributary of consequence except Little River, which enters the main stream 2 miles above Fulton. The oscillations are so rapid that frequently boats can run in one direction only on a single rise, and have to regulate their trips by the quantity and duration of rainfall in the upper river country.

The banks are covered with trees constantly caving or sliding into the river, and if the removal of obstructions from the channel were continued and the timber cleared from the banks to stop further accumulations, navigation would be safer and there would be less drift to contend with in the river below Fulton, but it is doubtful if the boating period would be lengthened or the upper limit extended.

I recommend one of two courses in regard to this part of Red River; either that no further work be done in it until there shall be a pressing demand for a considerable improvement from Fulton upward, including Little River, both to gain a better and longer period of navigation and to help drain the adjacent lands, or else that a liberal amount, say, not less than $10,000, shall be given in a single appropriation to allow the systematic clearing of the banks and removal of logs from the channel way to permit the bottom to scour. In no other way can the money be expended economically or any appreciable results obtained. The cost of organization and administration will be about the same for a small appropriation as for a large one, and the cost of getting the plant to the scene of operations and returning it to the fleet or other work will reach together nearly $1,000. The estimate is submitted with the idea of sending all the snag boats in Red River to work together under one management just as soon as the spring floods begin to subside, the snag boats to be employed on the wrack heaps and heavy obstructions and the chopping parties to clear the banks, so that all loose stuff shall go out on the first and succeeding rises. This will allow about six weeks' to two months' work of the snag boats, the lightest-draft boat being kept perhaps somewhat longer, and the boat with the chopping party continuing on downstream on bank work and small jams. About $1,000 should be held in reserve to send a snag boat over the whole the following season to dislodge heavy drift and pick up channel snags.

Money statement.

July 1, 1894, balance unexpended	$290.36
Amount appropriated by act of August 17, 1894	3,500.00
	3,790.36
June 30, 1895, amount expended during fiscal year	2,847.03
July 1, 1895, balance unexpended	943.33
July 1, 1895, outstanding liabilities	2.89
July 1, 1895, balance available	940.44
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

Red River above Fulton, Ark., was reported navigable for light-draft boats the entire year.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
					Light.	Loaded.		
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
Royal	44.82	86.6	24	3	1 2	3 0	Fulton, Ark., and Lanesport, Tex. / Fulton and Little River, Ark.	77
Gamma	44.32	84	18.4	4.3	3 0	3 6	Fulton and Little River, Ark.	5
Jennie Gilchrist	74.48	105.5	18.5	3.8	.....	.....	.....do	1

Summary of commerce reported.

Articles.	1894–95.	1893–94.	Articles.	1894–95.	1893–94.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Cotton	500	40	Staves	8,230	600
Cotton seed	1,000	1,500	Miscellaneous	5,898	110
Hides and skins	.....	1			
Live stock	20	475	Total freight	39,648	38,826
Lumber	.....	100			
Saw logs	24,000	36,000	Estimated value	$193,000	$133,000

The river, from the mouth of Kiamichi, the upper limit of the improvement, to Fulton, is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railway, a branch of the Atchison, Topeka and Santa Fe system, which crosses Red River at Arthur, Tex. The Texarkana and Fort Smith Railway crosses the river about 10 miles north of Texarkana, and the St. Louis, Iron Mountain and Southern Railway crosses at Fulton, Ark.

U 3.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The improvement of the waterway from Jefferson, Tex., down Cypress Bayou, across Fairy and Sodo lakes, and through Twelve-Mile Bayou to Shreveport, La., under the designation "improving Cypress Bayou," was commenced under river and harbor act of 1872. From 1872 to 1879 sums aggregating $94,000 were appropriated, and with this amount cuts were dredged in Cypress Bayou and from the bayou into the head of Fairy Lake, and leaning timber, sunken logs, and stumps were removed from the navigable channel. At the beginning of the work it was stated that dredging would make a limited improvement only, by rendering navigation easier and safer at high and medium stages, but that the navigable season would hardly be prolonged. In 1879 Major Benyaurd made no estimate for continuing work, but reported: "There are no more cut-offs that can be made to advantage, nor dredging to be done on the bayou, for when steamboats can pass Sodo Lake there is sufficient water in the channel above for all navigation purposes. In the lakes the dredge would be of no service. It is proposed during the next low-water season to send a working party across the lakes and cut down and remove all the cypress stumps and other obstructions in the channel already selected. When this work is executed it will give good navigation to Jefferson at a time when there is sufficient water for that purpose and will complete the project previously submitted."

In 1874 Captain Howell discussed various plans for improvement, the most favorable of which then appeared to be the construction of a dam across Sodo Lake at Albany Point and a dredged cut through to Red River at Gold Point. (Report Chief of Engineers, 1874, pp. 706–720.) No action upon this plan was taken by Congress, but the river and harbor act of July 5, 1884, directed that a resurvey be made "to ascertain if the necessary improvement could not be made upon some other plan than building a dam across the Albany Flats." An examination of the route was made, and it was found that the dredged cuts had shoaled and that the channel was more or less obstructed by stumps, etc. January 5, 1885, Captain Bergland submitted a project for reopening the cuts in the bayou and at head of Fairy Lake, removing stumps from the shoal water at Albany Flats and through Sodo Lake, making the entire depth available for navigation; straightening the channel in Fairy Lake and removing stumps to a depth corresponding to that obtained in Sodo Lake, and marking the channel selected through the lakes with signboards. It was estimated that this work would cost $18,000 and secure safe navigation between Jefferson and Shreveport for seven to eight months of the year. The act of 1886 appropriated $18,000, which was applied to carrying out the project. The act of 1888 allotted $5,000 of the appropriation for Red River to this work, which was applied to going over the route and removing obstructions. The

act of 1892 provided that $5,000 of the appropriation for Red River might be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes, and during the low-water season of 1893 the sum of $1,701.33 from this allotment was expended in going over the entire line from Shreveport to Jefferson, removing stumps, etc., in the channel and leaning timber along the banks of the bayous. This work put the stream in good navigable condition at any stage high enough to permit boats to pass Sodo Lake. Since 1888 the lakes and bayou have been navigable from seven to ten months of the year.

By resolution of the House of Representatives, February 6, 1890, a special report was called for respecting the improvement of Cypress Bayou and the lakes, and was submitted February 26, 1890. (Report Chief of Engineers, 1890, p. 1914.) This report contained an index of all former reports, the essential portions of previous examinations and plans and statement of work done under them, and was the basis of an extended survey provided for by river and harbor acts of 1890 and 1892 for the purpose of ascertaining if navigation could be materially and permanently improved by construction of dams, or locks and dams.

Final report upon the survey was made in 1893 (Report Chief of Engineers, 1893, p. 2065), with a plan for improving navigation between Shreveport and Jefferson by building a dam with waste weir across Sodo Lake, with entrance from Red River through Cottonwood Bayou by a lock with double gates. The cost of the work was estimated at $375,000, and the plan was discussed at length, with reasons in full for and against its advisability. The limited commerce to be benefited in comparison with the original cost of the work, annual charges of operation and maintenance, and the fact that the probable life of the improvement could not be estimated, rendered the question of the United States entertaining the project doubtful, to say the least, and this view appears to have been taken by Congress, as the river and harbor act of August 17, 1894, provided $10,000 "for dredging and removing obstructions and straightening channel between Jefferson, Tex., and Shreveport, La."

This appropriation appears to have been based upon a paragraph in my report upon the survey, reading as follows:

> Considering the needs of Jefferson alone, I should recommend improving the present channel from Jefferson to mouth of Twelve-Mile Bayou by removing the logs and cypress stumps, widening it by dredging, easing the curves, clearing the banks of the bayou of leaning timber, and marking the channel by clusters of piles, beacons, and buoys. This route would be navigable for boats that could cross the Albany Flats, and since there are no questions of drainage or discharge to be considered, the route could be shortened by cut-offs at every practicable place. With the route thus improved the only danger to navigation would be that of being blown out of the channel by high winds, which, however, could not be avoided even with slack-water navigation.

The appropriations for Cypress Bayou and the lakes have been as follows:

By act of—	
June 10, 1872	$10,000.00
March 3, 1873	50,000.00
August 14, 1876	13,000.00
June 18, 1878	15,000.00
March 3, 1879	6,000.00
August 5, 1886	18,000.00
August 11, 1888 (allotted from appropriation for Red River)	5,000.00
September 19, 1890, for survey	10,000.00
July 13, 1892, for survey	2,000.00
July 13, 1892 (allotted from appropriation for Red River)	1,701.33
August 17, 1894	10,000.00
Total	140,701.33

Work under the last appropriation has not been commenced. The amount available is too small to let the work by contract, as a large proportion would have to be allowed for towing and demurrage, making the cost per cubic yard excessive. The old dredge *Lone Star*, built before 1872, rebuilt twice, and repaired three times since, is very efficient for certain kinds of work, although out of date as a machine, but is not well adapted for this improvement. To use dump scows requires a depth too great for the dipper arm, and the arm and crane are not long enough to dump the spoil far enough from the edges of the cut to prevent sliding in, except by redredging. A new dredge, of the Hercules type, with spout, or traveler, is needed for general use in the district; the hull to be of steel, to insure long life and easy repair. Such a dredge, with minimum capacity of 100 cubic yards per hour, probably will cost about $30,000 to $35,000, and the running expenses, including repairs, average about $1,200 to $1,500 per month. Reference to these matters was made in my report upon the survey (Report Chief of Engineers, 1893, p. 2072), but the fact that a new dredge would be needed appears to have been overlooked when the appropriation was made. As a new dredge could be used to great advantage for the general improvement of Red River, recommendation was made in my project of August 23, 1894, that it be purchased from the appropriation for that work, and that a proper charge, say $50 a day, be made against the work in which used, to be repaid into the appropriation by which purchased. This recommendation failed to meet with approval at the time, however, and the work has been delayed for lack of plant. The purchase of a Hercules or ladder dredge, of the Bucyrus Company's make, built for the New Orleans and North Eastern Railroad in 1893, was authorized June 18, 1895, and it is the intention to use it upon this work as soon as practicable.

Money statement.

July 1, 1894, balance unexpended	$187.74
Amount appropriated by act of August 17, 1894	10,000.00
July 1, 1895, balance unexpended	10,187.74

COMMERCIAL STATISTICS.

Owing to extraordinary low stages, no boats ran between Shreveport and Jefferson during the year.

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IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita (the Indian name for black) River has its source in Polk County, Ark., and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until joined by Tensas and Little rivers at Trinity, La. Below this junction it is known as Black River, and flows in a southerly direction, entering Red River 35 miles above its mouth. The entire length of Ouachita River is about 500 miles and that of Black River is 47 miles.

The report on the Mississippi Delta Survey (Humphreys and Abbot, edition of 1876, p. 26), quoting from Darby, says:

Few rivers differ more in the quantity of water at different seasons than the Ouachita. Flowing from a hilly or mountainous tract, more constancy might be

expected in the column of water; but though the places drained by the Little Missouri and Fourche au Cado are not deficient in springs, yet the extensive region toward the sources of Ouachita has little water except what is supplied by rains in winter and spring. When the parching heat of summer has dried the country above the mouth of the Little Missouri the Ouachita becomes very low as far south as the head of Black River.

Under river and harbor act of 1870 an examination of Ouachita River was made (Report, Chief of Engineers, 1871, pp. 334–346), and work commenced in 1871 under a project for temporary improvement from Arkadelphia, Ark., to Trinity, La., by removal of snags, etc., and dredging the worst bars. A survey from Camden to Trinity was ordered by act of 1871, the report on which recommended improvement by locks and dams. (Report Chief of Engineers, 1872, pp. 367–374.) The project contemplated building five timber locks and dams, to last about twenty-five years, and to give 4 feet depth from Trinity to Camden, at an estimated cost of $1,163,083.75, exclusive of maintenance. Contracts were made for timber for foundations of three locks, but after a resurvey, completed in 1874, which showed faulty location of dams, that the locks proposed would be too small, that the least cost would be $2,626,252, and that locks would be idle at the time intended for use until a permanent improvement should be obtained at mouth of Red River, it was considered inadvisable to continue the work, and the project was abandoned. The contracts for timber were annulled, the material on hand sold at auction, and the proceeds turned into the Treasury, and the available funds were applied to construction and operation of a snag boat.

The project under which work below Camden has been carried on since 1874 contemplates the removal of snags, locks, wrecks, leaning timber, etc., obstructing navigation, and the improvement of shoals by dams and dredging. Black River was added under the same head of appropriation with Ouachita by act of 1884. The distance from Camden to mouth of Black River is 341 miles. No estimates of cost are given, as the nature of the work requires that it be continuous.

The appropriations have been as follows:

Date of act.	Locality.	Amount.
Mar. 3, 1871	Between Arkadelphia, Ark., and Louisiana State line	$25,000
Do	Between Arkansas State line and Trinity, La	26,000
June 10, 1872	Between Arkadelphia, Ark., and Louisiana State line	60,000
Do	Between Arkansas State line and Trinity, La	40,000
Mar. 3, 1873	....do	60,000
Aug. 14, 1876	Between Camden, Ark., and Trinity, La	12,000
June 18, 1878	....do	10,000
Mar. 3, 1879	....do	10,000
June 14, 1880	....do	8,000
Mar. 3, 1881	....do	12,000
Aug. 2, 1882	....do	12,000
July 5, 1884	Between Camden, Ark., and mouth of Black River, Louisiana	15,000
Aug. 5, 1886	....do	17,500
Aug. 11, 1888	....do	20,000
Sept. 19, 1890	....do	15,000
July 13, 1892	....do	40,000
Aug. 17, 1894	....do	50,000
	Total	432,500

The total amount expended to June 30, 1894, was $371,633.99, of which $258,046.12 were applied to operations under the project of 1874. The iron-hulled snag boat *O. G. Wagner* was purchased for the work in 1875, and repaired with a new steel bottom in 1886. Under provision of the act of 1888 the small wooden steamer *Hooker* was purchased that

year and fitted up for light snagging, and in 1894 a new hull was built for the boat, and its name changed to *Columbia*. Since 1875 operations were carried on whenever funds were available and conditions favorable, and consisted chiefly of the removal of snags, logs, wrecks, and tree slides from the channel and cutting leaning timber, though an increased depth was obtained at some of the shoals by wing dams built of stone or brush.

Operations during the fiscal year ending June 30, 1895, were continued as follows:

GENERAL IMPROVEMENT.

The U. S. snag boat *Wagner*, Watkins Decker, master, which had been laid up at Catahoula Shoals, was put in commission early in October, 1894, and October 9–18 was employed in removing snags and logs from the channel below Catahoula Shoals to Harrisonburg. The boat then ran to mouth of Black River, and commenced working upstream October 20. The river was at a low stage, and effective work was done; all obstructions in sight or that could be located with drag chain were removed. Two stumps, each about 4 feet in diameter, were removed from middle of river at Lost Bend, and notable improvement was effected at the following badly obstructed places in Black River, viz, Lum Bend, bend above Little Prairie, South Bend (from Magnolia to Monterey), Egypt, Kincaid Bayou, and Star View. The master of the tug making triweekly trips with the mail from Trinity to Tooley, on Black River, reported, on completion of this work, that he could save nearly six hours' time on the round trip, and pilots of commercial boats stated that all obstructions in the way of navigation through Black River had been removed. Above Trinity tree slides were removed at four places. Three and a half days were spent in pulling over Bayou Louis Bar, where the water was shoal for a long distance. The month of December was spent in removing obstructions from Bayou Louis Bar and opening a channel along the east side of the river between the mouth of Bayou Louis and Catahoula Shoals, the latter being supplementary to the work of dredging at the shoals. Since the channel through Catahoula Shoals was changed to the east side, it became necessary to clear the river below along that shore, to avoid the bar that will form below the dredged cut. The water is deep, but the bank is heavily timbered and caves badly at high stages, and as there was sufficient depth in the old channel in the middle of the river snag boats had done nothing for maintaining a channel on that side. The bottom was matted with large trees 2½ to 5 feet diameter at butt, 40 to 90 feet long, and with limbs intact, which had slid in from the bank and tangled and nested together. The stretch was cleared thoroughly, with exception of about 100 yards immediately below the cut, which was so full of mud lumps a snag boat could not be used. The work of the *Wagner* will prove of great benefit in keeping the shoals open and giving a straight channel below with 10 feet depth at low water. January 1–12 the river remained at a low stage, and all obstructions to navigation were removed between Catahoula Shoals and Columbia. On the 13th a rapid rise set in, in consequence of which snags and logs on the bottom could not be removed. The boat reached Monroe January 19, and remained there until the 23d undergoing repairs. During this period a fall set in, and the *Wagner* continued upstream, removing floating butts, caved-in trees, etc. Heavy rains January 25 and 26 caused a second rise, again preventing thorough work. Camden was reached February 2, and on the 4th the boat started back, doing any

work found necessary on the way. February 7 intensely cold weather set in, rendering the handling of lines impracticable, and on the 9th the boat returned to Monroe.

February 12–18 the *Wagner* was employed in towing the dredge, barges, and quarter boats from Catahoula Shoals to Monroe to undergo repairs. The river at Camden having fallen to a low stage during this time, supplies were obtained at Monroe, and February 20 the snag boat left again to work over the river to Camden. As far as Alabama Landing, La., 40¾ miles above Monroe, little could be done, as the water still was too high, but February 21 to March 8 the river was at a favorable stage, and effective work was carried upstream to Spoon Camp, 18 miles below Camden. A rise set in March 8, and during the succeeding three days the water rose 15½ feet on the Camden gauge. It being impracticable to continue work, the boat returned to Monroe March 11–13.

Accompanied by Assistant Engineers H. M. Marshall and T. C. Thomas, I made an inspection and reconnaissance of the river on the *Wagner* March 15–28. The boat left Monroe the morning of March 15, reached Camden the morning of the 20th, and turned back the afternoon of the same day, passed Monroe on the way down March 25, and reached Trinity the afternoon of March 28. On completion of this inspection the *Wagner* was transferred for temporary service in Bayou Bartholomew, but returned to the Ouachita April 24. Supplies were obtained at Monroe, and April 25 the boat left to again work over the river from Monroe to Camden. Operations were carried to Camden May 11, but heavy rains May 4 and 5, caused the river to rise rapidly, interfering with work upon the bottom. Between Champagnolle and Camden many snags were removed, however, that were not visible when the preceding trip was made over that stretch. The chief work consisted of removing slides and caved-in trees, the heaviest class of obstructions a snag boat has to contend with. Trees cave and slide into the river with large quantities of earth clinging to their roots, measuring 15 to 20 feet in diameter, making it difficult to remove them, and, as the upper river is narrow, such snags have to be cut into short lengths before they can be got out of the way. Below Fletcher Landing a large tree was removed that reached across the low-water channel; above Moro Bay a large oak tree was removed from the channel; two slides were removed about 1½ miles above Eldorado; between Franklin Shoals and Bangs Landing several large trees that had caved in were removed; and two trees were removed just below Spoon Camp that blocked the channel entirely. May 13–17 the *Wagner* returned to Monroe where it was laid up undergoing needed repairs until the end of June.

The following is a summary of the work done by the snag boat *Wagner* in Ouachita and Black rivers during the fiscal year ending June 30, 1895:

Snags pulled and blown up	798
Stumps pulled	88
Shore snags cut and blown up	857
Logs removed from channel	79
Stumps cut and blown up	164
Leaning trees cut	106
Trees girdled	26
Side jams removed	5

Wrecks removed, viz: Horsepower boat at Monterey (sunk before war) and small boat, name unknown, below Tredaway.

CATAHOULA SHOALS.

As Ouachita River was falling rapidly, the plant which had been laid up at Monroe, La., undergoing repairs during the high-water season, left that place July 4, 1894, in tow of the snag boat *Wagner*, and reached Catahoula Shoals Sunday, July 8. The stage of water being low enough to resume work at the shoals, the dipper of the United States dredge *Lone Star* was put up, the barges got ready, and dredging was resumed July 12. Work was continued under the supervision of G. W. Phillips, engineer of the dredge, without serious interruption until the date of completion, January 24, 1895.

The plan given in my report of 1891 (Report Chief of Engineers, 1891, p. 1967) was carried out, giving a good channel through the shoals to the left of the old channel 225 feet wide and 6 feet deep at low water. The material excavated consisted of rock, gravel, sand, and mud, part of which was used in building the dike above mouth of Little Creek, and part was deposited along the right shore, a small tug having been hired for moving the barges.

The following is a summary of the work done during the year, viz:

Material excavated	cubic yards..	53,492
Material placed in dike	do....	24,364
Material deposited along right bank	do....	29,128
Number of barge loads of material moved		1,287
Stumps and logs removed from channel		68

Wrecks removed, viz: Part of steamer *Little Bob* (sunk 1880).

It is not improbable that the work may have to be supplemented by dredging the channel below through Bayou Louis Bar, but this can not be decided until after another high water, when the canal above shall produce its maximum effect upon the channel. A careful survey should then be made of this reach to compare with the results of that made in 1890, and if dredging should be found necessary, it should be limited to the least depth and width required for existing needs of commerce on account of the small low-water discharge, which barely reaches 35 cubic meters per second.

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No special estimate can be made for contingent work, but if a comparatively small amount should be required for dredging the work can be done by the district plant and paid for from the allotment for general improvement.

SURVEY.

The act of August 17, 1894, directed the Secretary of War "to submit, with his next report on Ouachita River, plans and estimates for the improvement of said Ouachita River by locks and dams, to give slack-water navigation as far above its mouth as in his judgment such improvement is practicable, the cost of the same to be paid out of this appropriation."

In my project of August 30, 1894, I stated that it was not practicable to make a thorough survey of Ouachita River with the whole appropriation, nor practicable to make a report to the Secretary of War at the next session of Congress upon the feasibility of a slack-water system in a river that ranges 46 feet at Camden, 49 feet at Monroe, and 55 feet at Trinity.

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The importance of the work proposed required that the survey should be made on an extensive and thorough scale, for which an estimate of

$150,000 was submitted in my report of 1890 and repeated each succeeding year. If the project be feasible, this sum is small in comparison with the cost of a slack-water system that must be expressed in millions even under the most favorable conditions, and it is not too much to spend to protect the United States before entering upon so costly an improvement.

I stated that it should be accepted frankly at the outset that the appropriation was intended to begin the survey as estimated by me, and to carry it as far as the funds would permit the work to be done thoroughly, it being well known that the river and harbor bill was cut down because of the condition of the Treasury, and the reports of the arguments and speeches on this item before the committee, when my estimate was used, stated that $50,000 was all that could be granted at the time, and the people interested would have to be satisfied until the next appropriation.

Recommendation was made that $20,000 of the appropriation of 1894 be applied to continuing snagging operations, etc., for general improvement of the river, and that the balance of $30,000 be allotted for beginning the survey, for which a balance of $120,000 would be required to complete, unless progress of the work should indicate that reductions may be made.

Levels of precision were considered of first importance, and the opinion was given that no other field work should be undertaken until their completion. A line having been run in 1893–94 from Vidalia, on the Mississippi, to Trinity, and thence up the Ouachita to Monroe, it was proposed to continue it down Black River from the bench at Jonesville, opposite Trinity, to the benches of Red River survey. On closing at Red River the party was to be transferred to Monroe and continue upstream if conditions were favorable. A second party was to begin on the Coast Survey benches at Little Rock and carry levels along the railroads to Camden, crossing upper Ouachita at Arkadelphia, and from Camden down the river until the first party should be met, closing the line from Little Rock to Red River. With the levels gauges were to be established at a number of points selected on going over the river, as at the mouths of tributaries and other places considered necessary, and high-water marks were to be connected with the line of levels.

This project was approved September 7, 1894, and the latter part of that month a precise level party was organized at Jonesville, La., under Assistant Engineer W. H. Polk. Precise bench marks 3, 4, and 5 and temporary benches 27 and 28 were leveled to to ascertain if any changes in elevation had occurred since they were set the preceding year, and September 25 leveling commenced at precise bench mark 4 at Jonesville, was carried down Black River to its mouth, and finished November 12, 1894, connecting with the following reference points of Red River survey, viz: Triangulation station 439, jars marking discharge sections below and in Black River, and two high-water sections of gauge at the mouth. From Jonesville this line was run down the right bank of Black River to Joseph Montgomery's, where it crossed a neck, then crossed the river to Calhoun Landing, and thence up the left bank to Hardscramble Landing, where it crossed another neck and came to the river at Lum Landing. Below the latter place to New Era it continued along the left bank, and below New Era it was run along the public road to Delhoste at mouth of Black River. November 16–18 the quarter boat was towed back to Jonesville and discharge measurements of Black, Ouachita, Little, and Tensas rivers were taken. This work was finished December 1, and December 2–4 the quarter boat was moved

up to Catahoula Shoals to measure discharge at that point. On completion of the latter work, December 21, the party was disbanded for the winter, or until a favorable time for continuing the line above Monroe.

A second party, under Assistant Engineer T. C. Thomas, commenced precise leveling at Little Rock, Ark., October 18, 1895. By courtesy of the chief engineer of the Missouri Pacific Railway System, a hand car was furnished to move the party from place to place, and for use in going to and returning from work; the pilot, an employee of the company, was paid for his services by the United States. At Little Rock the United States Coast and Geodetic Survey benches were tested, to detect any changes in elevation that might have taken place, and the Engineer and Weather Bureau gauges and their reference benches were connected with the precise benches. The line of precise level, started at Coast Survey Bench I or 3, was carried along the main line of the St. Louis, Iron Mountain and Southern Railway to Gurdon, and thence along the Camden branch to Camden, and the work was completed to the latter place December 17. At Camden the Engineer gauge and reference benches were leveled to, and a branch line run to the St. Louis Southwestern Railway Bridge across Ouachita River. Below Camden leveling was continued along the branch railroad to Elliott, Ark., and thence 8.5 kilometers along country roads and through the woods to Frenchport, 13¼ miles by river below Camden. The latter place was reached December 31, and as the weather was not favorable for continuing the line downstream the party was disbanded.

After suspension of field work assistants Thomas and Polk were retained at the office to work up the notes.

March 15–28, 1895, accompanied by assistants Marshall and Thomas, I made a reconnoissance of the river on the snag boat *Wagner* from Monroe to Camden, and thence down to Trinity, for the purpose of becoming more familiar with the stream, to recover if possible and permanently mark benches of the surveys of 1871 and 1873, and to lay out plans for resuming field work. The notes of 1871 and 1873 and maps of 1873 were taken along, and throughout the trip the topography was compared with the maps, mounted on a revolving table and oriented by compass. All important changes in landings and ownership of lands were noted, a careful search was made for benches of the old surveys, and inquiry made for high-water marks. All benches and high-water marks found were connected by level with permanent marks set near by, or with benches of precise levels of 1893–94, where the latter were near at hand. Four authentic benches of the survey of 1873 were recovered, and probably four others; twelve high-water marks were found and leveled to; a gauge was set up at Champagnolle, Ark., and the gauges at Camden, Ark., Riverton and Jonesville, La., were tested. Bulletins were erected at all four stations to give passing steamboats the stage of water at each gauge reading.

The following work has been done in the office:

All the precise level notes have been worked up, and sketches and elevations of the permanent benches and river crossings made. The field notes of the survey of 1873 have been reviewed, and the transit line plotted on scale of 1:10,000 from Camden to Monroe, the original scale, 1:2,400, being too large for convenience for a general map, while too small for detail for probable sites of locks and dams. This work will be finished by the end of July, and as soon as the conditions are favorable active field work will be commenced. The precise levels will be resumed at Frenchport and continued to Monroe, to close on the

main line of the Louisiana net, a distance of about 248 kilometers, as estimated from the transit line of 1873. The level party will precede the topographical party, and on reaching Monroe, if the weather and stage of river are favorable, will begin the topographical survey at that point and continue downstream, or move upstream to some convenient point, depending upon the progress of the first topographical party, which will begin work at Camden, the object being to complete the work from Camden down as far as possible during the first working season. The second season will be devoted to finishing the survey to the junction of Black with Red River, taking discharge measurements at highest and lowest stages, and to running out the lines on Bayous Bartholomew, D'Arbonne, Bœuf, Tensas, and Maçon. The importance of accurate levels can not be dwelt on too persistently.

To improve this river by any plan requires an accurate knowledge of the high and low water limits, a profile of the bed, and the discharge at extreme stages. To improve it by locks and dams requires also an accurate profile of both banks. The maps of 1871 give no elevations or stations, and those of 1873, whether correct or not, will not furnish a bank profile, since the levels were run generally under the banks and across necks, speed apparently being the motive. The replot of the map of 1873 will be used in the field as a guide, and it is proposed to plot the new survey on the same scale in the field, so that corrections may be made on the spot and finished as the survey progresses. Plotting directly on tracing vellum will be tried, and if the experiment succeeds blue prints can be made as soon as each sheet is done, thus saving not only money but an immense amount of time. The latter is of especial importance, considering the impatience of those interested in the results of improvements.

The discrepancies between the levels of 1871 and 1873 have been mentioned in former reports, but it was not until the precise line from the Coast Survey benches at Little Rock had reached Camden that the extreme variations could be stated. Connections with benches of 1873 show great irregularity in the running, some being much too high while others were found too low.

To judge only by extremes, the levels of 1871 were remarkably good, but the discovery of other benches may disprove their excellence. The following table shows the variations between three stations, about the beginning, middle, and end of the surveys. The benches are those of 1871, distances given in kilometers, estimated from the map of 1873, and elevations above Cairo datum given in feet for convenience, the metric system not having been used on the earlier work:

Bench.	Distance.	P. L. 1894.	Levels 1871.	Levels 1873.
144 Camden	0	125.620	126.500	123.752
		(—36.677)	(—37.590)	(—38.759)
103 Monroe	269	88.948	88.910	84.993
		(—11.066)	(—11.033)	(— 7.116)
2 Trinity	473	77.877	77.877	77.877
Total differences		—47.743	—48.623	—45.875
Discrepancies between Trinity and Monroe	204	0.000	— 0.033	— 3.950
			0.000	— 3.917
Discrepancies between Monroe and Camden	269	0.000	+ 0.913	+ 2.082
			0.000	+ 1.169
Total discrepancies between Trinity and Camden	473	0.000	+ 0.880	— 1.868
			0.000	— 2.748

From this table it will be seen that, as compared with the precise levels, those of 1873 lost 3.950 feet between Trinity and Monroe and recovered 2.082 feet between Monroe and Camden. Connections between the precise levels and bench 30 of 1873 at Sinnots, 72 kilometers below Monroe, and bench 33, opposite Columbia, only 23 kilometers farther downstream, show that 0.712 foot was gained between Monroe and bench 30, making the latter 3.238 feet too low, and that 0.654 foot was gained in the short run to bench 33, leaving an unaccounted error of 2.584 feet between Columbia and Trinity, a distance of 109 kilometers. None of these errors can be detected in the level notes, which, however, are not believed to be original; but the subsequent discovery of bench 34 and the possible finding of others on the way may reduce this error so much as to give a certain value to the profile of 1873, and perhaps that of 1871. These details are given to show the futility of railroad methods in making river surveys, and to emphasize the necessity of accurate work, especially upon streams so sensitive as Ouachita and of such small low-water discharge.

To locate locks and dams by levels so variable as those of 1873 appear to have been would be to invite serious risks—such as having a dam backed out and a lock flooded by a sudden rainfall above the average, or in finding knee-deep water on a miter sill planned to give 7 feet at the lowest stage. For an extreme example of sensitiveness of an alluvial stream the following is taken from the record of the gauge at Alexandria, on Red River, Louisiana:

June 14–16, 1886. Forty-four hours' rain, 28.58 inches fell; river rose from 3.6 to 28.75 feet June 16, 5 p. m. Local storms.

From such gauge records as we have of Ouachita River at Camden, Monroe, Riverton, and Black River Station, rise and fall of several feet in an hour are not infrequent, and the water seldom remains at a stand for any length of time except during protracted droughts, when the river is at its low summer stage. Finally, the completion of the precise levels and the recovery of all extant benches probably will give a certain value to all the old records, both of permanent and temporary gauges—information which is now lying idle for want of datum.

The following table, in the metric system, shows the information obtained thus far by the precise levels of 1893–94. Elevations to the nearest centimeter are referred to the Cairo datum, a plane 6.3613 meters below the mean Gulf level of the U. S. Coast and Geodetic Survey from observations at Biloxi, Miss. Distances from Camden were derived from the reconnaissance map of 1870 between Arkadelphia and the State line and from the maps of 1873. High-water marks of 1882 were obtained from gauge records or by levels to marks pointed out as authentic. Low water was derived from the gauge records without regard to year:

Place.	Distance.	Gauge zero.	Low water.	High water, 1882.	Range.
	Kilos.	*Meters.*	*Meters.*	*Meters.*	*Meters.*
Arkadelphia	144.84	55.89	56.19	63.42	7.23
Camden, Ark	0.00	27.74	28.29	41.74	13.45
Monroe, La	269.23	15.62	15.64	30.42	14.78
Sinnots Landing, Louisiana	341.10	.....	.....	27.67	.....
Riverton Bridge, Louisiana	357.77±	10.73	11.11	27.50±	16.39±
Columbia, La	364.21	.....	.....	27.45	.....
Danville, La	408.23±	.....	.....	27.39	.....
Mouth of Bœuf River	435.00	.....	9.40±	26.54±	17.14±
Harrisonburg, La	447.75	.....	.....	26.22	.....
Trinity, La	473.14	7.56	8.38	25.33	16.95
Mouth of Black River, Red River, Louisiana	563.20±	0.00	8.08	23.84	15.76
Red River Landing, La., Mississippi River	607.60±	7.27	7.27	22.05	14.78

This table shows two extreme conditions—a mountain torrent between Arkadelphia and Camden, with fall at low water of almost 28 meters, say 2 decimeters per kilometer, or an average of about 1 foot to the mile, and an almost level pool between Trinity and Red River, the fall at low water being 3 decimeters in 90 kilometers, or an average of less than one-quarter of an inch to the mile. In the former case no permanent improvement could be made except by locks and dams, so many in number as to form almost a flight of locks, an undertaking that could not be urged with any hope of success unless great mineral deposits should be found. In the latter case it is evident that dredging the bars between Trinity and Red River would be the simplest and most expeditious—in fact, the only practical method of improvement. There being almost no fall in this reach, dredging in the lower part should not reduce the depth on bars above, which always occurs in streams of great slope when improvement is attempted by local dredging. These two facts fully justify the limits adopted in 1871 and 1873 for improving the river by locks and dams only between Trinity and Camden. The key to the system is the bar at the mouth of Red River, as stated by Captain (now Lieutenant-Colonel) Benyaurd, and unless that can be kept below a certain depth it would be useless to attempt slack-water navigation on Ouachita River.

The low-water season of 1894 was somewhat like that of 1873, Mississippi River and nearly all its tributaries falling to an extreme low stage, in several instances some feet lower than ever before recorded, but it is reported that there were no detentions on account of low water at the mouth of Red River during that time. But admitting that the bar may form again, the project now in hand to make a new channel is expected to obviate the trouble, so that it is reasonably safe to proceed as if it were an accomplished fact.

The plans of 1871 and of 1873 contemplated the improvement of Ouachita River alone between Trinity and Camden, and no effort appears to have been made to collect information about the tributaries. These are Little River, formed by Bayous Dugdemona and Castor entering from the west at Trinity, Tensas, and Maçon, which unite and enter Ouachita from the east just above Trinity, giving together about 370 kilometers of high-water navigation; Bœuf River, entering from the east at Stafford Point, about 38 kilometers above Trinity, giving a high-water navigation of about 200 kilometers; Bayou D'Arbonne, entering from the west a short distance above Monroe, navigable at high water to Stein Bluff, a distance of about 70 kilometers; Bayou Bartholomew, entering from the east about 42 kilometers above Monroe, and navigable at high stages as far as Baxter, a distance estimated at about 240 kilometers. The Saline River enters from the east about 155 kilometers below Camden. It was classed among the navigable streams for a time, and appropriations made for its improvement, but nothing has been done for some years, and no information is available as to its navigability. It is a considerable river, and probably could be made a valuable tributary to the main stream at a moderate cost. No surveys have been made of the Bartholomew, Bœuf, or Tensas and Maçon, and the information about them is meager, but in running levels across Louisiana from Delta Point to Monroe benches were established and high-water marks of 1882 and gauges connected at the crossings of Tensas, Maçon, and Bœuf River, from which I have obtained the fall at high and low water between the several points and Ouachita River, as follows:

Place.	High water, 1882.	Low water.	Range.
Bayou Macon: Delhi	33.03	21.39	11.64
Ouachita: Trinity	25.33	8.38	16.95
Fall	7.70	13.01	.....
Bœuf River: Girard	30.39	22.22	8.17
Mouth of Bœuf River: Stafford Point	26.54±	9.40±	17.14±
Fall	3.85	12.82	.....

It is said that Bayou Bartholomew has a very gentle slope, and Bayou D'Arbonne has been surveyed, and the levels may be used when the main survey reaches that stream. Now, it is evident that if these streams have a moderate slope, or a slope at all comparable with that of the main stream, the water would be pooled in them to the same distance from a dam as in Ouachita River, and, therefore, in planning any system of locks and dams for the latter the site and lift of the dam could be adjusted to benefit each in the inverse ratio of their slopes without materially changing the cost of a system devised for Ouachita alone, which, by way of contrast, might be placed in the latter case in such manner as to be of small or no value to a tributary on the one hand or an injury to the lands adjacent to it on the other.

Taking up the main question: The opinion of Assistant Engineer Clement Smith in his report upon the project of 1871 to the late Colonel Raynolds, and that of Captain Benyaurd upon the survey of 1873 that it was feasible to improve Ouachita River by locks and dams, even though based upon imperfect information, seem to be sound; but Assistant Smith's plan for fixed dams, with an average lift of 14 feet, does not commend itself for a stream so sensitive as the Ouachita, especially as the river was liable to sudden great additions through the eastern tributaries from crevasses in the Mississippi River levees on Tensas Front. Happily, with the extension of the levee system, this danger has been averted, or at least reduced to a minimum, so that Ouachita may be counted upon carrying only the natural drainage of its own basin. Colonel Raynolds probably felt this danger, for he made estimates on a system requiring ten dams, with average lift of 7 feet, and Captain Benyaurd's estimates were in the same direction, providing for seven, eight, and ten dams under three cases presented by him. (Report Chief of Engineers, 1874, p. 354.) The advantages of fixed dams consist chiefly in the reduced charges for repair, and in requiring men only for operating the locks. The disadvantages are briefly: The greater number required, increasing the cost of construction and operating, and the fact that they can be passed only by locking, except at high stages, requiring very high lock walls. The advantages of a system of movable dams are self-evident. While the sills of the dams may be put very much lower than the crests of fixed dams, the pools may be raised considerably higher and therefore made longer, and the number of dams diminished.

The only movable dams on a large scale in this country are those with Chanoine wickets in successful operation on Ohio and Kanawha rivers. The objection to such a system on Ouachita River would seem to be that needles would be required to close the intervals between shutters, the low-water discharge being so small, say about 25 cubic meters per second at Monroe and 35 cubic meters at Catahoula Shoals, that it is doubtful if shutters alone would raise the pools to the required height. The cost of operating upon a sensitive stream would also be

increased. The modified bear trap would seem to be the form indicated for Ouachita River. The subject is discussed in a report of a Board of Engineers upon the project of Maj. William A. Jones for that form of construction at Sandy Lake Dam, Minnesota. (Report Chief of Engineers 1893, p. 2269.) It is stated in the report that there are several of these movable dams in successful operation, notably at Nevers, Wis., on St. Croix River, the largest with an opening 24 meters wide and 4¾ meters head. There were several models in the exhibit of the Corps of Engineers at the World's Fair which worked admirably. Major Jones's opinion is that the head may be increased considerably with perfect safety upon good foundations, and that openings may be made as wide as the needs of commerce demand. The subject has been investigated practically by lumber men, and was taken up as an engineering question under Major Jones by Lieutenant Chittenden and Assistant Engineer Powell, and continued by the former under Captain Warren, with a view to applying the system to the locks of Louisville and Portland Canal. Some notices have appeared in the engineering journals, and it is hoped that the whole investigation will be published for the benefit of the profession at large, as well as of the Corps of Engineers.

Assuming this form of dam to be practicable, the Ouachita system may be improved by its use with a less number of dams than would be required by any other form, with the nearest approach to an open river during the higher stages, and prolong both the main stream and the contiguous tributaries. Since the dam is a hydraulic gate, no men besides the lock tenders would be needed to operate it. Sudden rises could be provided for by lowering the dam to any height below its normal position when up, thus keeping the river at about the same elevation until it should be advisable to throw the dam and use the navigable pass. The lock walls need not to be carried up to an excessive height, and the leakage at extreme low water undoubtedly would be much less than by the Chanoine system for the same width and height of pass or weir.

We do not know the bank heights, except at a few points, but from observations on high-water marks in making the reconnoissance of last March we do know that on certain parts the river overflows the country to a greater or less extent at high stages. In order to avoid excessive levee construction the rule in adjusting the system would be to fix the maximum elevation of each pool at a safe height below the lowest point on either bank between the dam below and the point where the pool would back out, say 3 meters or more, to provide for sudden rises. Each succeeding dam upstream would have to be located both with reference to the best site and also with reference to the navigable depth to reach the lower lock gate. The dimensions of the locks must be adjusted to the largest boats now in use, with reasonable allowance for increased demands of commerce. Dredging would be required to a certain extent in order to get the best location.

As heretofore stated, the information is very incomplete, but we have definite elevations at four important points: Camden, Monroe, Riverton Bridge above Columbia, and Trinity at the head of Black River. The lowest recorded stage at Camden was 28.27, or 1.8 feet on the present gauge, or about the same as the estimated low summer water of the survey of 1871 as found from the level connections. At this stage the river is a deep pool, but very shoal on the rocks and gravel bars below Camden. To give a navigable depth to Camden would require the pool to register about 10 feet on the present gauge, say about 31 meters Cairo datum,

or a considerable amount of dredging on the bars below. The lowest recorded stage at Trinity was 8.38, or about 2.7 feet on the Black River Station gauge, about the same as noted in 1873 from level connections. It is not probable that the water ever will fall to zero on this gauge, judging from the lowest water at the mouth of Black River or that at Red River Landing on Mississippi River, and therefore it should be safe to assume the level at extreme low water at Trinity at 7.5 meters Cairo datum. On this basis the extreme height to be overcome would be 23.50 meters (say 77 feet), which may be done without encountering any insurmountable engineering difficulties by four, five, or six movable dams, averaging 5.875, 4.7, or 3.920 meters each above their sills, or in common measure about 19.25, 15.42, and 12.85 feet, respectively.

To avoid what some may fear to be too great lifts, and to keep the charges for operating within reasonable limits, as estimated from the reported expenses on other rivers, I have prepared a table to illustrate the idea of adjusting the dams so as to benefit the nearest tributaries, assuming that the banks will be at fairly safe heights above the successive pool levels.

Table suggesting approximate location for five movable dams to include tributaries.

[Elevations refer to Cairo datum.]

Pools.	Distance.	Length of pool.	Low water.	Elevation of pool.	Lift of movable dam.	Location of dam.	Service of pool.
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meters.*		
Camden	0	.....	.....	.....	.....		
5 to Moro Bay.....	104	104	28.27	31.0	4.7	Below Moro Bay..	Ouachita and Moro Bay.
4 to Ouachita City	226	122	.....	26.3	4.8	Below Ouachita City.	Ouachita, Bartholomew, and Saline.
3 to Monroe.....	269	43	15.64	21.5	4.7	Below Monroe....	Ouachita and D'Arbonne.
2 to Stafford Point.....	435	166	.....	16.8	4.8	Below Stafford Point.	Ouachita and Bœuf River.
1 to Trinity	473	38	8.38	12.0	4.5	Below Trinity	Ouachita, Tensas, and Macon, and Little River.
Black River, lowest sill, Dam No. 1.	.....	.....	.....	7.5	.....	.....	

The act of August 17, 1894, directed the Secretary of War "to submit with his next report on Ouachita River, plans and estimates for the improvement of said Ouachita River by locks and dams, to give slack-water navigation as far above its mouth as in his judgment such improvement is practicable, the cost of the same to be paid out of this appropriation."

So far as practicability is concerned, it is perfectly practicable to improve the whole river by locks and dams as high as its head waters, but since the question is one of judgment by the Secretary of War, the benefit not only to the people living in Ouachita Valley but to the people at large should be considered. The only means I have of answering this question are in the commercial statistics collected and reported year by year. This year they are enlarged by a tabulated statement made from data collected and furnished by the Camden Commercial League, composed of business men in the upper valley, who have taken great interest in this matter. In fact, as I understand, the item in the last river and harbor bill authorizing the survey was due to

representations and arguments made by a committee of the league before the River and Harbor and Commerce committees of Congress at the last session, following upon the revival of interest in the subject by letter of Hon. C. J. Boatner to the Secretary of War in December, 1889, requesting an estimate of the cost of a survey for this purpose. If the statistics are accepted as a satisfactory showing that the project will pay, then the improvement is one worthy to be undertaken by the United States, and the plan is certainly practicable so far as to include Camden at the present time. But it would be very unwise to begin at any point, whether at the lowest point, or in the upper river as was attempted in 1872, until the survey has been thoroughly done and the best system attainable worked out.

With regard to the cost of such a system, it is not possible to make any detailed estimates, and only to offer a probable maximum in general terms. The probable size of locks required now, with allowance for larger boats as the commerce develops, is one of the first questions for determination. The official list published by the Bureau of Navigation gives only the net dimensions of boats in some cases, and is not safe as a guide. For example, the largest boat in the Ouachita trade is the *Ouachita*, official dimensions: Tonnage, 457.75; length, 189 feet; breadth, 38 feet; depth, 6.5 feet. Dimensions reported by the master to this office: Tonnage, 372; length over all, 220 feet, from stem to outer end of wheel arms; breadth over guards, 52.5 feet; loaded depth, 10 feet. If the latter is correct this would require a lock about 240 feet long between quoins, 55 feet wide, and at least 10.5 feet depth on miter-sills. How a boat listed officially at 6.5 feet depth can be loaded to 10 feet draft is not apparent, and actual measurement would be required. Large boats have been loaded at St. Louis at high water with freight for Ouachita as high as Camden, among them the *Dacotah*, listed in the official volume as follows: Gross tonnage, 956.98; net tonnage, 726.09; length, 252 feet; breadth, 48.3 feet; depth, 5.5 feet. If these are net measurements then the lock would have to be at least 275 feet long between quoins, 60 feet or more wide, and probably 12 feet deep on the miter sills.

If the commerce of Ouachita Valley should develop to such a degree as those who are urging this improvement estimate, the largest locks would be demanded. The dimensions of the locks on Illinois River are: Length of lock chamber, 350 feet; width of chamber, 75 feet; depth at low water over sills, 7 feet. Among the list of boats passing La Grange lock in 1893–94 were the *Cherokee* of 631 tons, *Ferd Herold* 900 tons, *Grey Eagle* 555 tons, and *Spread Eagle* 529 tons, the last two being side-wheel boats and probably over 60 feet from out to out of guards.

Barge towing is practiced now on Ouachita during the higher stages, and therefore locks would have to be of such size as to take them in, say two abreast and two or more fore and aft. The solution of this part of the question lies between the maximum chamber that can be filled within a reasonable time without depleting the pools, the extreme low-water discharge being so small, and the minimum that will satisfy the needs of a developed commerce upon a fair estimate. As an approximation to the dimensions of the locks, length may run from 100 to 120 meters, breadth from 20 to 25 meters, and depth on the sills from $2\frac{1}{2}$ to $3\frac{1}{2}$ meters.

The object of movable dams is to give a near approach to an open river during the higher stages, both for navigation and to accommodate the discharge at high water, which may be over one hundred times that of low water on Ouachita River. The navigable passes should be at

least equal to the width found safe for the openings in swing bridges, say 40 or 50 meters. The navigable pass at Dam No. 7, on Great Kanawha, is about 75 meters and the weir about 92 meters wide. The width of Ouachita at any probable site, measured from the map of 1873, is such that possibly two openings of about 50 meters with smaller ones to act as sluices would answer. The amount of revetment or of probable levee work near the dams, or at some specially low breaks in the banks along the pools, can not be estimated from the maps of 1873, the only information now at hand. Undoubtedly works of both kinds would be required, and certainly the revetment work to prevent flanking.

Assistant Smith's estimates of 1871 were as follows:

5 locks, 250 by 49 feet, lift 14 feet, cut stone,	$2,194,916.35
Average cost	438,983.27
5 locks, same dimensions, timber (estimated life, 25 years)	1,163,083.75
Average cost	232,616.75

Colonel Raynolds's estimates, 1871:

5 locks, 200 by 40 feet, lift 14 feet, cut stone	$1,995,649.15
Average cost	399,129.83
10 locks, 200 by 40 feet, lift 7 feet, cut stone	2,595,114.90
Average cost	259,511.49

Captain Benyaurd submitted estimates in 1874, dimensions based upon those of the side-wheel boat *Ouachita Belle* (250 by 67½ by 8½ feet), and of the stern-wheel boat *Lotawanna* (180 by 47 by 6 feet), the boats being the largest of their class then on Ouachita River:

First. Locks large enough for the *Ouachita Belle* to Camden:

7 locks, 300 by 70 by 10 feet, cut stone	$4,952,976.00
Average cost	707,568.00
7 locks, same dimensions, timber	2,644,768.00
Average cost	377,824.00

Second. Locks for *Ouachita Belle* class to Monroe, and for *Lotawanna* class to Camden, involving rehandling for largest boats at Monroe:

3 locks, 300 by 70 by 10 feet 5 locks, 250 by 49 by 8 feet } cut stone	$5,162,319.00
Average cost of 3	707,568.00
Average cost of 5	607,923.00
Average cost of 8	645,289.88

Third. Locks for *Lotawanna* class only:

10 locks, 250 by 49 by 7 feet, cut stone	$6,079,233.00
Average cost	607,923.30
10 locks, same dimensions, timber	2,995,566.00
Average cost	299,556.60

Captain Benyaurd stated that these estimates were high because the cost was "largely increased on account of the character of the country in which the improvement is contemplated, as it offers no facilities for securing skilled labor or material of any kind except timber, and requiring every other material that would be used in the construction of the works to be brought from a distance and before navigation closed, thus greatly enhancing the cost, in addition to which any number of claims would be brought against the Government for damages supposed to be done to the lands on account of the pools created by the dams."

Conditions have changed very considerably since that time, both in the reduced cost of materials and in the extension of facilities for transportation, so that it may not be unreasonable to diminish Captain Benyaurd's estimates by perhaps as much as 25 per cent. The dams were all fixed in every case, and the proviso in regard to claims for possible

damages was a good anchor to windward. It furnishes also another argument for accurate levels, so that the absolute height of the highest authentic watermarks may be known and placed upon record *in advance*. This already has been done as far as possible on the lines between Monroe and Red River, and Little Rock, Arkadelphia, Camden, and Frenchport, and additions will be made in carrying on the survey.

For the same reasons as given by Captain Benyaurd the estimates of 1871 are considered to have been too low, but they may be assumed as fairly good estimates at the present time. The only other means for estimating the probable cost of a system is to take the statements of cost for somewhat similar works on other rivers, like the Great Kanawha, Ohio, or Illinois, and from bids lately received for locks.

Lock No. 7, Great Kanawha River, 342 by 55 by 8 feet, cut stone, cost as nearly as can be ascertained from reports	$169,523.24
Movable dam	132,519.38
	302,042.62
Engineering contingencies, estimated at 10 per cent	30,204.26
Land damages, surveys, storehouses, office, etc., not known.	
Total over	332,246.88

Bids of May 18, 1895, for portions of Lock No. 1, Osage River, including grubbing, excavation, cofferdams, land wall to height of upper miter sill, partial completion of wing walls, etc., ranged from $138,613.10 down to $73,990, the accepted bid. There were ten bidders, and all but three bid under $100,000. It probably would be safe to estimate the cost of the lock completed for operation at $150,000. Kampsville fixed dam on Illinois River cost about $56,000, but I am unable to arrive at the cost of the lock, 350 by 75 by 7 feet, as the expenditures are not classified in the several reports. The noteworthy success of Major Marshall in building concrete locks on Illinois and Michigan Canal, known as the Hennepin route, induces the belief that the cost of a system of locks on Ouachita could be reduced very largely by following that method. The details are not yet published, but it is understood that after the foundations were ready for the superstructure it was completed in 168 hours continuous work. Major Marshall states that the night shifts accomplished more than those working by daylight. Whatever kind of masonry should be chosen—and it would be false economy to try to save on first cost by using timber—continuous work should be required to avoid the danger of being overtaken by sudden rises.

The following is offered as a preliminary estimate for a lock suited to the probable needs of commerce, with movable dam to be open at medium and higher stages:

Lock 120 by 25 by 3.5 meters, more or less	$175,000
Dam with navigable pass of 50 to 60 meters	125,000
Land damages, storehouses, lock tender's house, office, etc	63,364
Engineering contingencies, etc	36,636
Total	400,000
Total for a system of 5 from Trinity to Camden	2,000,000

While this amount can not be regarded as an estimate in the proper sense of the term, I am of the opinion that it gives a liberal margin of safety, and that it may be accepted as the superior limit of cost, including all contingencies. The cost of operating can be estimated only from reports on similar works, but since the dams are to be hydraulic gates the men required for the lock service should be sufficient. Probably an average of $5,000 a year would cover such expense and the

contingencies of accident at each lock. I recommend prosecuting the survey thoroughly, as estimated in my report of 1890 upon the subject. (Report Chief of Engineers, 1891, pp. 1969–1972.)

Of the appropriation of $50,000 for improving Ouachita River in the act of August 17, 1894, the Chief of Engineers allotted $30,000 for the survey, which would require $120,000 to complete according to the original estimates.

As a matter of interest and to justify the somewhat severe condemnation of early levels, the report of Assistant Engineer Thomas upon the adjustment of the net of precise levels run in this engineering district in Louisiana is given in full. This work has not been surpassed in any department of the United States, but in referring to the levels of 1871 and 1873 it must be acknowledged that they probably were as good as that class of work was anywhere at that time. Speed was the railway requirement, and such errors as have been noted of small moment, as it was easy to adjust grades from section to section.

REPORT OF MR. T. C. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., May 7, 1895.

CAPTAIN: I have the honor to submit report on the adjustment of a net of levels, precise and ordinary, in the State of Louisiana.

These levels were run by (1) the Coast and Geodetic Survey; (2) the Mississippi River Commission; (3) the Red River survey, and (4) the Ouachita River survey, as detailed below.

(1) *By Coast and Geodetic Survey.*—Precise levels from Smithland, along the Mississippi River to Delta, and passing through Black Hawk Landing and Vidalia (1880–81), 248 kilometers; being part of a line run from tide water at Biloxi, Miss., through New Orleans to the precise level bench at Greenville, Miss., upon which precise levels of the Mississippi River Commission closed from Cairo, Ill.

(2) *By Mississippi River Commission.*—Ordinary levels from mouth of Grand Cut-off Bayou to Black Hawk Landing, run in conjunction with a topographical survey of the Mississippi River (1882), 3 kilometers.

(3) *By Red River survey.*—(*a*) Precise levels from Delta, La., along Vicksburg, Shreveport and Pacific Railroad through Monroe to Shreveport, thence down Red River to Barbin Landing, thence across country to Smithland, touching Red River at head of the Atchafalaya, 654 kilometers. From Delta to Shreveport these levels were run preliminary to, and from the latter point on, in conjunction with a topographical survey of Red River from Shreveport to head of Atchafalaya (1889–1892).

(*b*) Ordinary levels from Barbin Landing down Red River to mouth of Black River, Bayou Cocodrie, and head of Atchafalaya, 70 kilometers.

(*c*) Ordinary levels from Bayou Cocodrie to a bench mark (stone line point $\frac{144}{4}$) of the Mississippi River Commission, near mouth of Grand Cut-off Bayou, 6 kilometers. The ordinary levels were run in conjunction with the topographical survey of Red River (1891–92).

(4) *By Ouachita River survey.*—(*a*) Precise levels from Vidalia to Jonesville via Natchez, Red River and Texas Railroad, thence up Ouachita River to Monroe (1893–94), 180 kilometers.

(*b*) Precise levels from Jonesville down Black River to its mouth (1894), 54 kilometers.

These levels were run preliminary to a prospective topographical survey of Ouachita River.

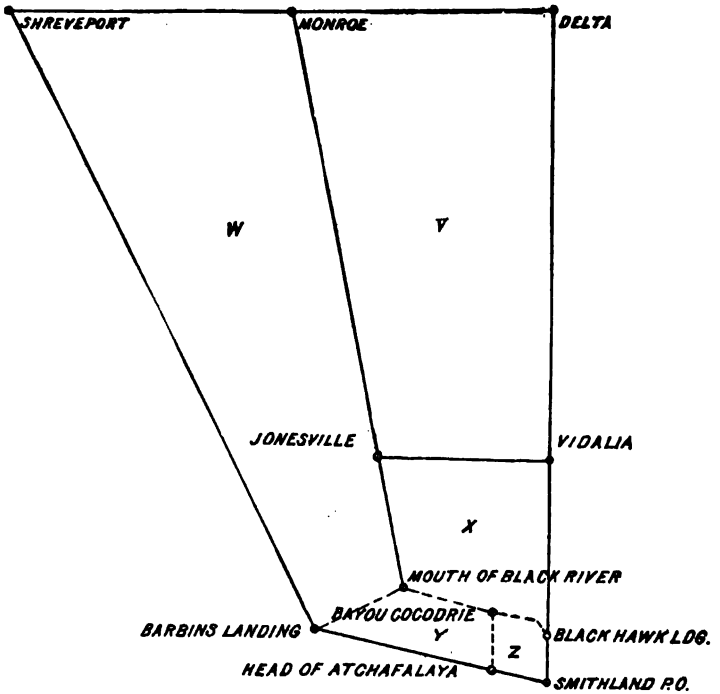
(On the following page is a sketch of the several lines. Precise levels are shown in continuous, ordinary levels in broken lines.)

The instruments employed on the precise-level lines were practically equal in grade. Their distinguishing features, as compared with the ordinary leveling instruments, are a sensitive bubble tube (3 to 5 inches per division), and a wye bar hinged at one end and resting on the point of a finely threaded screw at the other, enabling the observer to set the delicate bubble accurately.

For the Coast and Geodetic Survey levels, errors due to nonadjustment of instrument were eliminated by observing with telescope normal and inverted, and bubble tube direct and reversed. Each sight was corrected for inequality of pivots, curva-

ture and refraction computed as functions of length of sight, and for temperature of brass scale on rod. From Smithland to Bielas Landing (168 kilometers) two simultaneous lines were run in one direction over each stretch, alternate stretches being run in opposite directions. From Bielas Landing to Delta (80 kilometers) independent lines were run in opposite directions over each stretch. The greatest allowable discrepancy between runs, whether simultaneous or independent, was 5 mm. into square root of twice the length of stretch in kilometers (5 mm. $\sqrt{2K}$).

For the precise levels run by the Red and Ouachita river surveys, instrumental errors, curvature, and refraction were eliminated by keeping fore and back sight distances very closely balanced at all points of a run. If at end of a run these distances were found not balanced, the difference of elevation found for the terminal benches was corrected for instrumental errors, the corrections being computed as functions of the difference between the sum of foresight distances and sum of back sight distances for the run. Each stretch was leveled in duplicate, original and check line being run in opposite directions, and by the same observer. The limiting discrepancy for nearly all of these levels was 5 mm. into square root of length of stretch in kilometers (5 mm. $\sqrt{K}$).



The ordinary levels of the Red River survey were run in a succession of loops, the check line closing back on the initial bench by a different route from that followed by the original line up to the terminal bench of loop. The ordinary levels of the Mississippi River Commission were checked by closing on bench marks of the Coast and Geodetic Survey precise levels.

For the precise-level line the mean of simultaneous runs or of forward and back runs over each stretch was adopted. In each loop of the ordinary levels the error of closure was distributed among the several benches of the loop in proportion to the number of intermediate instrument settings.

For the Mississippi River Commission ordinary levels, the precise bench marks connected with were assumed to be correct, and the error of closure on such benches was distributed through the ordinary level line in proportion to the number of instrument settings. It will be observed that this local adjustment of individual loops for the ordinary levels assumes the discrepancies to be a linear function of the distance—since the number of settings will generally be proportioned to the distance—and hence that a constant cumulative error is the predominant source of the

discrepancies in the observations, and the adjustment for individual stretches of the precise-level line is not inconsistent with this assumption. The local adjustment has already been made; it is mentioned to show, in conjunction with what will follow, the assumptions on which the complete adjustment of the net is based.

The discrepancies in the several loops of the net (see sketch), after making the adjustment just described, are as follows:

Loop.	Length of line.		Error of closure.
	Precise.	Ordinary.	
	Kilom.		*Mm.*
V	395	.....	18
W	661	29	62
X	137	27	65
Y	89	70	47
Z	47	32	40
V + W + . . + Z	902	.....	22

A preliminary general adjustment of the net was made on the assumption that the errors left in the levels by the local adjustment were accidental, and therefore proportional to the square root of distance run, and that the error per unit distance (taken as 1 kilometer) is the same numerically for all the precise level line. An error different in amount from the above, but following the same law, was assumed for the ordinary levels.

Taking the error in each side of the several level polygons as equal to the *square root* of its length into the *error per kilometer* for its class of levels (precise or ordinary), an *observation* equation was formed for each loop of above table, except the last. From these equations the most probable values of the errors per kilometer were calculated. These unit errors are $\pm 0.5\,(+)$ millimeter, and $\pm 10.0\,(+)$ millimeters for the precise levels and ordinary levels, respectively. Correcting the levels for these unit errors the several loops close as shown in last column of following table:

Loop.	Original error of closure.	Correction by preliminary general adjustment.			New error of closure.
		To precise levels.	To ordinary levels.	Total.	
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
V	18	17	.....	17	1
W	62	9	54	63	1
X	65	4	72	76	11
Y	47	3	36	39	8
Z	40	5	18	23	17
V+W+ . . +Z	22	24	.....	24	2

A final adjustment was then made to remove the small discrepancies left in the several loops by the preliminary general adjustment. The discrepancies were assumed to be due to accidental error, and the error per unit distance to be different for different sides of the loops, though so nearly equal for all levels of the same class, that precise level lines could—between themselves—be given weights in inverse proportion to their lengths; and the same for lines of ordinary levels—between themselves. The relative weight of the two classes of levels remains to be determined. If the observations were subject to accidental error alone the weight could be best determined *a posteriori* from a comparison of the discrepancies between duplicate runs over individual stretches of the precise level line with the discrepancies in the individual loops of the ordinary line. But it is now universally admitted that such discrepancies are principally due to *constant error;* and the above method is not applicable. In the present case it was endeavored to determine the relative weight *a priori* from a consideration of the relative sensitiveness of the bubble tubes used, and the probable relative accuracy of reading the rods for the two classes of levels. The bubble tube used on the ordinary levels of the Red River Survey was compared with the bubble tube of one of the precise levels used on same survey, and the angular equivalents of equal linear spaces on the two found to be in the ratio of 9 to 1, making the sensitiveness of the precise tube nine times that of the ordinary tube. Again, the greater part of the precise levels were run with self-reading rods. Each of three horizontal spider lines was read on the rod and the mean taken for the *rod reading.* For the ordinary line run by the Red River Survey a self-reading rod was used, which was read on one spider line.

From the above consideration it appears that the accidental errors of equal lengths of precise and ordinary line are in the ratio of 1 to $9\sqrt{3}$ ($=1:15.6$) and their weights in the ratio of $(15.6)^2$ to 1^2 ($=243:1$). The preliminary general adjustment gave the accidental errors per kilometer for the two classes of levels a ratio of 1:19.4. The derivation of the latter ratio is *a posteriori*, and is based on data from which constant error has been largely eliminated by the local adjustment; but the *a priori* determination has been adopted on account of the limited number of observation equations (5) on which the other determination is based. That the *a posteriori* solution should give the higher ratio, is reasonable when it is remembered that the *a priori* solution does not take into account the confinement of precise level observations to favorable atmospheric conditions—the shielding of the instrument from the sun while in use, and the accurate balancing of fore and back sight distances practiced on *precise* work.

The weight of any precise level line of the system can be expressed by

$$\frac{C}{\text{Length of line}}, \text{ and of any ordinary line by } \frac{C}{(15.6)^2 \text{ Length of line}};$$

C being an arbitrary constant (made equal to 40 in the present adjustment). The weights having been determined, the most probable system of corrections satisfying the conditions that the final differences of elevation for the several sides of each loop shall sum to zero was determined by Gauss's method of correlates. The net involves six loops, but these are not independent, a system of corrections satisfying the closure condition for any five of these, also satisfying the sixth. That the number of independent conditions is only five appears from the following:

The differences of elevation between n points can be determined by $n-1$ lines of levels, hence every line in excess of that number will be superfluous, and furnish an equation of condition. If a system of n points be joined by p lines of levels the number of independent conditions will be $p-(n-1)$. In the present case $n=12$ and $p=16$, hence the number of independent conditions is 5. In the present adjustment equations of condition were formed for the five interior loops of the net.

The necessary data was compiled from Coast and Geodetic Survey Report 1888, Appendix XI; Chief of Engineers Report 1893, Appendix V; manuscript tabulations and notebooks in the Vicksburg engineer office, and results furnished by letter from office of Mississippi River Commission. This data is embodied in the following table:

Bench mark.	Locality.	Elevation.	Route of levels.	Length of line.	Class of levels.
		Meters C. D. 20.983	Smithland (initial point of net).	*Kilos.*	
C. and G. S. P. B. M. XLV ..	Smithland	21.005	Smithland, Delta, Shreveport, Barbin, Atchafalaya, Smithland.	902	Precise
C. and G. S. P. B. M. LIII ..	Black Hawk Landing.	22.128	Smithland, Black Hawk Landing.	66	Do.
C. and G. S. P. B. M. LXIII.	Vidalia	24.830	Black Hawk Landing, Vidalia.	42	Do.
C. and G. S. P. B. M. 215	Delta	34.084	Vidalia, Delta.....	140	Do.
		29.966	Vidalia, Delta, Monroe...	256	Do.
Red River Survey P. B. M. 27.	Monroe	29.948	Vidalia, Jonesville, Monroe.	180	Do.
R. R. S. P. B. M. 45	Shreveport	59.610	Monroe, Shreveport.....	155	Do.
R. R. S. T. B. M. 51*a*	Barbin Landing.	23.553	Shreveport, Barbin Landing.	313	Do.
		20.439	Barbin Landing, head of Atchafalaya.	47	Do.
R. R. S. P. B. M. 90	Head of Atchafalaya.	20.392	Barbin Landing, Black River, head of Atchafalaya.	70	Ordinary.
Ouachita River Survey, P. B. M. 4.	Jonesville.....	22.630	Vidalia, Jonesville.....	41	Precise.
		20.612	Vidalia, Jonesville, mouth of Black River.	95	Do.
R. R. S. △439.....	Mouth of Black River.	20.692	Vidalia, Delta, Shreveport, Barbin's, mouth of Black River.	724 29	Do. Ordinary.
McCalla's Reference Point 24 (R. R. S).	Mouth of Bayou Cocodrie.	17.994	Black River, Bayou Cocodrie.	18	Do.
		23.574	Black Hawk Landing, Grand Cut-off Bayou.	3	Do.
Mississippi River Commission Stone Line Point $\frac{144}{4}$.	Mouth of Grand Cut-off Bayou.	23.589	Black Hawk Landing, Delta, Shreveport.	766	Precise.
.....	.....	.....	Barbin's, Black River, Grand Cut-off Bayou.	53	Ordinary.

Coast and Geodetic Survey benches have been referred to Cairo datum by adding 6.3613 m. to Coast and Geodetic Survey published elevations.

Slight changes have been made in the elevations of Coast and Geodetic Survey Bench Mark LXIII, and Red River Survey Precise Bench Mark No. 27. These benches were connected with adjacent benches, in their respective localities, in starting the Ouachita River precise levels at Vidalia (1893) and closing them at Monroe (1894). These connections indicate slight changes in the benches named. The elevations adopted result from a local adjustment of the 1893–94 connections. Following are the corrections indicated by the adjustment:

Stretch.	Terminal benches.	Difference of elevation.	Correction.	Corrected difference of elevation.
		Meters.	*Meters.*	*Meters.*
Head of Atchafalaya, through Smithland, to Black Hawk Landing.	R. R. S. P. B. M. 90 to C. and G. S. P. B. M. LIII.	+1.711	+0.005	+1.716
Black Hawk Landing to Vidalia.....	C. and G. S. P. B. M. LIII to P. B. M LXIII.	+2.702	— .003	+2.699
Vidalia, through Delta, to Monroe...	C. and G. S. P. B. M. LXIII to R. R. S. P. B. M. 27.	+5.136	— .009	+5.127
Monroe, through Shreveport, to Barbin Landing.	R. R. S. P. B. M. 27 to T. B. M. 51*a*.....	—6.413	— .012	—6.425
Barbin Landing to head of Atchafalaya.	R. R. S. T. B. M. 51*a* to P. B. M. 90.....	—3.114	— .003	—3.117
Vidalia to Jonesville.....	C. and G. S. P. B. M. LXIII to O. R. S. P. B. M. 4.	—2.200	+ .003	—2.197
Jonesville to mouth of Black River..	O. R. S. P. B. M. 4 to R. R. S. △ 439.....	—2.018	+ .004	—2.014
Jonesville to Monroe.....	O. R. S. P. B. M. 4 to R. R. S. P. B. M. 27	+7.318	+ .006	+7.324
Barbin Landing to mouth of Black River.	R. R. S. T. B. M. 51*a* to △ 439.....	—2.861	— .052	—2.913
Mouth of Black River to mouth of Bayou Cocodrie.	R. R. S. △ 439 to McCalla's R. P. 24 (R. R. S.)	—2.698	+ .038	—2.660
Bayou Cocodrie to Black Hawk Landing.	McCalla's R. P. 24 (R. R. S.) to C. and G. S. P. B. M. LIII.	+4.149	+ .023	+4.172
Bayou Cocodrie to head of Atchafalaya.	McCalla's R. P. 24 (R. R. S.) to R. R. S. P. B. M. 90.	+2.398	+ .058	+2.456

Differences of elevation are given the algebraic sign corresponding to the direction indicated in first column of table.

The probable error per kilometer is $\pm$ 0.57 mm. for the precise level lines and $\pm$ 8.97 mm. for the ordinary. The probable error per kilometer for the Coast Survey levels included in this net, as computed from the discrepancies between runs over the individual stretches, varies from 1.12 mm. to 1.18 mm. (See C. and G. S. Report 1888, p. 464.)

The wide difference between the values resulting from the Coast and Geodetic Survey reduction and the one in hand is explained by the fact that the value $\pm$ 0.57 is based on data from which the local adjustment attempts to eliminate constant error. That this has been largely accomplished is probable from the small errors of closure for the several loops of the net.

The constant error that would be eliminated by the local adjustment (that is, by taking the mean or half sum of duplicate runs over a stretch) must be such as to make one result excessive and one deficient by equal amounts. Such an error would disappear from the sum of the two results, but affect their difference by twice the error of one result. Hence the probable error as computed from the differences of duplicate runs over the individual stretches would be excessive.

It can not be assumed in the general case that a local adjustment such as that described above will eliminate all the constant errors to which a line of levels may be subject. For example, a displacement of the plumb line due to the local attraction of mountain masses, etc., would introduce errors which would not be so eliminated. In such a case the differences of elevation given by duplicate runs over a stretch would be both excessive or both deficient, and the error would affect their mean by its full amount, but disappear from their difference. Under such circumstances the probable error computed from the discrepancies between duplicate runs over individual stretches would be too small.

"It is a general experience that the probable error so obtained proves too small, as shown by the discrepancies appearing at crossings and from interlacing lines of levels." (Charles A. Schott, Coast Survey Report, 1887, p. 196.)

The general experience is reversed in the present net of levels, and it is reasonable to conclude that these levels are not affected by constant errors other than the cumu-

lative error, tending to cause a divergence between forward and back runs over the several stretches; which errors are practically eliminated by the local adjustment.

A résumé of the numerical work is appended.

Very respectfully,

T. C. THOMAS,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

DATA.

Each loop is designated by a letter (see sketch); the outside loop is designated by "U." Each line is designated by joining the letters designating the loops to which the given line is common. Differences of elevation are given the sign corresponding to the directions in which results for the several lines are tabulated. This direction is left handed for the loop whose letter precedes in the symbol for the line.

[Lines marked with star (*) are ordinary levels; all others precise.]

Line.	Difference of elevation.	Length of line.	Line.	Difference of elevation.	Length of line.
	Meters.	*Kilos.*		*Meters.*	*Kilos.*
V U	+5.136	256	Z U	+1.711	89
W V	+7.318	139	X U	+2.702	42
W U	−6.413	468	X V	−2.200	41
W Y*	−2.861	29	X W	−2.018	54
Y U	−3.114	47	X Y*	−2.098	18
Z Y*	+2.398	23	X Z*	+4.149	9

Sum (algebraic) of differences of elevation for each interior loop.

[Each loop is here assumed to be leveled in the right-hand direction.]

(V U)	(W V)	(W U)	(W Y)	(Y U)	(Z Y)	(Z U)	(X U)	(X V)	(X W)	(X Y)	(X Z)	=	Loop.
												Mm.	
−1	+1							+1				=−18	V
	−1	−1	−1						+1			=−62	W
			+1	−1	+1					+1		=−47	Y
					−1	−1					+1	=+40	Z
							−1	−1	−1	−1	−1	=+65	X

REMARKS.—The numbers in body of table are the coefficients of the quantities at head of the several columns.

Equations of condition.

[In terms of corrections to observed differences of elevation.]

(v u)	(w v)	(w u)	(w y)	(y u)	(z y)	(z u)	(x u)	(x v)	(x w)	(x y)	(x z)	Absolute term.	
												Mm.	
−1	+1							+1				+18	=0
	−1	−1	−1						+1			+62	=0
			+1	−1	+1					+1		+47	=0
					−1	−1					+1	−40	=0
							−1	−1	−1	−1	−1	−65	=0

(v u) = correction to V U; (w v) = correction to W V, etc.

Preliminary general adjustment.

[Observation equations formed from the equations of condition on hypothesis of an error $\pm a\sqrt{\text{length}}$ for each precise-level line and $\pm b\sqrt{\text{length}}$ for each ordinary-level line.]

a	*b*	Absolute term.	=
		Mm.	
$+\sqrt{256}+\sqrt{139}+\sqrt{41}$	.....	−18	=0
$+\sqrt{468}+\sqrt{54}-\sqrt{139}$	$+\sqrt{29}$	−62	=0
$+\sqrt{47}$	$+\sqrt{18}+\sqrt{23}-\sqrt{29}$	−47	=0
$+\sqrt{89}$	$+\sqrt{23}-\sqrt{9}$	−40	=0
$+\sqrt{41}+\sqrt{54}-\sqrt{42}$	$+\sqrt{18}+\sqrt{9}$	−65	=0

Preliminary general adjustment—Continued.

Reduced observation equations.				Normal equations.			
a	*b*	Absolute term.	=	*a*	*b*	Absolute term.	=
		Mm.				*Mm.*	
34.2	.....	−18	=0	+1863.6	+186.8	−2847.7	=0
17.1	+5.4	−62	=0	+ 186.3	+ 93.2	−1034.0	=0
6.9	+3.6	−47	=0				
9.4	+1.8	−40	=0				
7.2	+7.2	−65	=0				
				$a = \pm 0.52$ *mm.* $b = \pm 10.05$			

Corrections.

Line.	$\sqrt{\text{Length.}}$	Difference of elevation.	Correction ( )'.	Corrected difference of elevation.	Line.	$\sqrt{\text{Length.}}$	Difference of elevation.	Correction.	Corrected difference of elevation.
		Mm.	*Mm.*	*Mm.*			*Mm.*	*Mm.*	*Mm.*
V U.....	16.0	+5186	− 8	+5128	Z U....	9.4	+1711	+ 5	+1716
W V....	11.8	+7318	+ 6	+7324	X U....	6.5	+2702	− 3	+2699
W U....	21.6	−6413	−11	−6424	X V....	6.4	−2200	+ 3	−2197
W Y....	5.4	−2861	−54	−2915	X W...	7.3	−2018	+ 4	−2014
Y U.....	6.9	−3114	− 3	−3117	X Y....	4.2	−2698	+42	−2656
Z Y	4.8	+2398	+48	+2446	X Z....	3.0	+4149	+30	+4179

Corrections computed from the functions 0.5 $\sqrt{\text{length}}$, and 10.0 $\sqrt{\text{length}}$.

Closure of loops after preliminary general adjustment.

[Each loop is assumed to be leveled in a right-hand direction.]

(V W)'	(W V)'	(W U)'	(W Y)'	(Y U)'	(Z Y)'	(Z U)'	(X U)'	(X V)'	(X W)'	(X Y)'	(X Z)'	=
−1	+1							+1				=+ 1
	−1	−1	−1						+1			=− 1
							−1	−1	−1	−1	−1	=+11
			+1	−1	+1					+1		=+ 8
					−1	−1					+1	=−17

Final general adjustment.

[Equations of condition.]

(v u)''	(v w)''	(v x)''	(w u)''	(w y)''	(w x)''	(x u)''	(x y)''	(x z)''	(y u)''	(y z)''	(z u)''	Correlate.			Loop.
−1	+1	+1										− 1	=0	A	V
	−1		−1	−1	+1	−1	−1	−1				+ 1	=0	B	W
		−1			−1							−11	=0	C	X
				+1			+1		−1	+1		− 8	=0	D	Y
								+1		−1	−1	+17	=0	E	Z
6	3	1	2	176	1	1	109	55	1	140	2	..... 1/p			

Weight (=p) is here taken equal to 40/length for precise-level line and 40/(15.6)² length for ordinary.

Normal equations in terms of correlates.

A	B	C	D	E			Normal equation in—
+10	− 3	− 1	.....	.....	− 1	=0	A
− 3	+192	− 1	−176	.....	+ 1	=0	B
− 1	− 1	+167	−109	− 55	−11	=0	C
	−176	−109	+426	−140	− 8	=0	D
		− 55	−140	+197	+17	=0	E

A = + 0.13, B = + 0.07, C = +0.12, D = + 0.08, E = +0.005.

Corrections in terms of correlates.

Correction.	1/p	A=+0.13	+B=+0.07	+C=+0.12	+D=+0.08	+E=+0.005	Numerical value of corrections.
(v u)''	6	−1					−1
(v w)''	3	+1	−1				0
(v x)''	1	+1		−1			0
(w u)''	12		−1				−1
(w y)''	176		−1		+1		+2
(w x)''	1		+1	−1			0
(x u)''	1			−1			0
(x y)''	109			−1	+1		−4
(x z)''	55			−1		+1	−7
(y u)''	1				−1		0
(y z)''	140				+1	−1	+10
(z u)''	2					−1	0

Total corrections.

Stretch.	(Correction)'	(Correction)''	Total correction.
	Mm.	*Mm.*	*Mm.*
(v u)	− 8	− 1	− 9
(v w)	+ 6	0	+ 6
(v x)	+ 3	0	+ 3
(w u)	−11	− 1	−12
(w y)	−54	+ 2	−52
(w x)	+ 4	0	+ 4
(x u)	− 3	0	− 3
(x y)	+42	− 4	+38
(x z)	+30	− 7	+23
(y u)	− 3	0	− 3
(y z)	+48	+10	+58
(z u)	+ 5	0	+ 5

Computation of probable error.

Correction. (=v)	Weight.	V²	V²×weight.
− 9	.00391	81	.316
+ 6	.00719	36	.259
+ 3	.02441	9	.220
−12	.00214	144	.308
−52	.00014	2704	.378
+ 4	.01852	16	.297
− 3	.02381	9	.214
+38	.00023	1444	.333
+23	.00046	529	.243
− 3	.02130	9	.192
+58	.00018	3364	.606
+ 5	.01125	25	.281

$\Sigma V^2 \times \text{weight} = 3.647.$

FORMULA.

$r_0 = .6745 \sqrt{\Sigma \frac{p\, v^2}{N}}$ where p = weight of any line of levels, V the correction for that line, and n = number of equations of conditions. r_0 = probable error of a precise level line of unit weight = 1 kilometer. $r_0 = \pm 0.57$. r_0' = probable error of 1 kilometer of ordinary levels $= \frac{r_0}{\sqrt{15.6}} = 8.97$. Weight is here made equal to $\frac{1}{\text{length}}$ for precise levels, and $\frac{1}{(15.6)^2 \text{length}}$ for ordinary.

GENERAI REMARKS.

Snagging operations have been very beneficial but should be continued vigorously for some years Some river men advocate the use of small flatboats with steam capstan power, but practical experience has

demonstrated that it is a waste of money to build cheap snag boats. Strong hulls and surplus power are needed to handle large snags and heavy timber, and such obstructions as a weak boat could handle can be disposed of more expeditiously and at less cost by chopping parties and a liberal use of explosives. The method first adopted on Red River of clearing the banks for some distance from the water's edge, especially where slips are liable to occur and at sharp bends, should be followed on this stream, beginning in the upper part. Good quarter boats to accommodate parties of twenty to thirty men and the necessary outfit of tools offer the best means for this work, leaving the heavy work for the large boats. Should dredging be found necessary to give local temporary relief, the district plant may be used at comparatively small expense. But dredging in advance of a definite plan for giving permanent navigation by any system should be practiced with great caution, especially in the river above Columbia where the slope increases considerably above that of the river below. The survey may show that some benefit may accrue from closing chutes with dams made of timber cut from the banks during the progress of the work, but the nature of the bed in the upper river is such that no great scour should be expected from this class of work. During the progress of the survey probable sites for dams will be examined and borings made to ascertain the character of the bed for considerable depth. Final sites will of course be supplemented by more elaborate surveys and the maps plotted upon a much larger scale, probably not less than one one-thousandth for practical working drawings, except for details, which of course would require still larger scales.

The serious discussion of the project for locks and dams which is now being urged can not be taken up until the accurate profile of the river in all the details of bed, banks, and high and low water has been obtained.

ESTIMATES.

Completing the survey	$120,000
Quarter boats for chopping parties	3,000
Outfits, tools, and repairs	3,000
Expenses of snag boats	35,000
Expenses of chopping parties	6,000
Expenses of dredges	4,000
Office charges, mileage, transportation, etc	4,000
Total	175,000

The amounts expended during the fiscal year were as follows:

For general improvement, repairs, care of plant, etc	$15,247.87
For Catahoula Shoals	9,932.53
For survey	6,841.38
Total	32,021.78

Money statement.

July 1, 1894, balance unexpended	$10,866.01
Amount appropriated by act of August 17, 1894	50,000.00
	60,866.01
June 30, 1895, amount expended during fiscal year	32,021.78
July 1, 1895, balance unexpended	28,844.23
July 1, 1895, outstanding liabilities	11.92
July 1, 1895, balance available	28,832.31
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	175,000.00

COMMERCIAL STATISTICS.

Navigation for regular packets during the fiscal year was reported as follows: Mouth of Black River, Louisiana, to Camden, Ark., July 1 to July 15, 1894, and January 12 to June 30, 1895; to Monroe, La., July 15 to August 15, 1894, and December 5, 1894, to June 30, 1895. There was navigation for light-draft boats to Harrisonburg the whole year. The mouth of Red River was open to navigation the entire year.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Ouachita	Stern-wheel.	457.45	189.0	38.0	6.5	4 0	10 0	New Orleans and Monroe, La.	15	653
City of Camden	..do ...	297.00	175.0	35.0	5.5	2 2	5 6	New Orleans, La., and Camden, Ark.	12	689
								New Orleans and Harrisonburg, La.	14	
								New Orleans and Columbia, La.	1	
								New Orleans and Alabama Landing, La.	1	
								New Orleans, La., and New London, Ark.	1	
								New Orleans, La., and Champagnolle, Ark.	1	
								New Orleans, and Refugio, La.	1	
Albert Lea	Side-wheel.	24.47	64.8	12.3	4.0	2 6	4 0	Jonesville and Little River, La.; odd trips at high stages.	.....	.....
Parlor City	Stern-wheel.	136.30	125.0	26.0	3.7	2 0	5 0	Monroe and Bayou Bartholomew, La.	4	....
								New Orleans and Monroe, La.	12	816
								New Orleans and Catahoula Shoals, La.	8	....
								New Orleans and Harrisonburg, La.	17	....
								Monroe and Bœuf River, La.	14	25
Belle of D'Arbonne	..do ...	74.59	111.0	22.0	3.7	2 0	4 0	Monroe and Bayou D'Arbonne, La.	17	49
								Monroe, La., and Camden, Ark.	28	176
Helen Vaughan	..do ...	89.95	100.5	25.0	4.2	1 0	3 6	Monroe and Bayou D'Arbonne, La. (Books burned; no report.)	.....	.....
Joe (with barges)	Tug ..	18.07	44.5	10.0	4.0	5 6	5 9	New Orleans, and Bœuf River, La.	1	....
Danube	Stern-wheel.	232.32	175.0	33.8	5.1	2 0	5 0	New Orleans and Tensas River, and Bayou Maçon, La.	8	30
Marco	..do ...	43.90	104.3	19.0	2.6	1 0	2 0	Jonesville and Monroe, La.	1	....
								Jonesville and Tensas River, and Bayou Maçon, La.	11	4
Marcus Collins	..do ...	48.14	90.0	17.0	2.5	1 1	2 6	Trinity and Little River, La.	25	30
								Trinity and Bayou Maçon, La.	40	....
Laura Blanks	..do ...	62.73	104.8	21.3	3.8	1 6	3 6	Trinity and Little River, La.	30	100
								Trinity and Columbia, La.	10	
								Trinity and Riverton, La.	2	
								Trinity and Bayou Maçon, La.	30	
Sterling White	Side-wheel.	117.09	120.0	30.5	4.2	2 6	4 6	Monroe and Alabama Landing, La.	5	....
								Monroe and Bœuf River, La.	1	....
								Monroe and Bayou Bartholomew, La.	15	60

List of steamboats engaged in the trade during the fiscal year—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Lillie (towboat)	Stern-wheel.	61.42	120.0	26.0	3.5	2 6	3 6	New Orleans and Jonesville, La., and towing logs between Jonesville, and mouth Red River.	1	....
Gasoline	..do	14.00	80.0	9.0	2.0	0 7	1 10	Monroe and Bayou D'Arbonne, La.	47	....
Dora (with barges)	Tug	3.00	31.0	7.0	4.5	3 0	4 0	Jonesville and Tooley, La. (Carries U. S. mail.)	148	520
H. M. Townsend (towboat)	Stern-wheel.	87.70	116.7	18.0	3.1	.....	.....	New Orleans, La., and Saline River, Ark.	1	....
Alvin	..do	201.55	143.0	29.1	7.1	.....	.....	New Orleans and Ouachita City, La.	1	....
								New Orleans and Delhi, La.	1	....
Le Vere	..do	98.73	109.2	23.9	2.9	0 7	2 10	Monroe and Bayou Bartholomew, La.	20	....
								Monroe, La., and Marie Saline, Ark.	27	10
Irwin (with barges)	Tug	.....	.....	.....	.....	.....	.....	Stafford Point and Bœuf River, La., triweekly trips.	.....	.....
Gen. H. F. Devol (towboat)	Stern-wheel.	156.99	130.0	22.5	3.8	.....	.....	New Orleans, La., and Camden, Ark.	3	....
G. W. Lyon (towboat)	..do	86.17	115.0	22.0	4.4	.....	.....	.....do	1	....
Rosa B	..do	41.85	82.0	16.0	4.0	1 4	3 0	Monroe and Bayou D'Arbonne, La.	10	26
Lura	..do	8.00	50.0	12.0	2.0	1 0	3 0	.....do	8	....
Julia H	Tug	4.88	.....	.....	.....	.....	.....	Stafford Point and Bœuf River, La., triweekly trips.	.....	.....
Alarm (towboat)	Stern-wheel.	189.09	142.0	26.0	4.3	.....	.....	New Orleans and Carriol, La.	1	....

During the year the steamboats *Gasoline* and *Lura* were sunk, and the *Helen Vaughan*, *Laura Blanks*, and *Marcus Collins* were burned.

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	21,070	11,176	11,383	21,890	21,433	16,652	17,788
Cotton seed	6,005	3,645	4,423	5,577	6,593	5,058	2,660
Hides and skins	166	72	4	7	25	36	23
Live stock	329	549	845	89	172	62	213
Lumber	218	262	18,000	461	16,388	7,951	5,963
Saw logs	10,000	28,257	28,000	26,880	120,000	50,000	.....
Staves	18,891	31,519	9,378	23,402	17,888	21,159	8,599
Rock	.....	.....	.....	.....	18,000	.....	.....
Miscellaneous	5,660	6,572	5,251	5,197	10,856	783	1,096
Total down freights	62,339	82,052	77,284	83,503	211,355	101,701	36,342
Return freight	11,340	13,808	11,157	18,317	27,842	40,766	24,228
Total	73,679	95,860	88,441	101,820	239,197	142,467	60,570
Estimated value	$3,293,000	$3,430,000	$4,466,000	$6,680,600	$9,130,000	$10,234,250	$8,798,000

The unusually low stage of the river during the fiscal year affected the timber and stave business appreciably, one stave firm alone having 512,000 staves on the bank awaiting transportation. Of the above freights it is estimated that Saline River contributed 5,000 tons, valued at $165,000.

The following statistics, compiled from information furnished by the Camden Commercial League, show the resources of the country whose commerce, with uninterrupted navigation, could be made tributary to Ouachita River:

Population of territory affected (1894)		539,436
Annual cotton crop (estimated)	bales..	782,395
Estimated value		$31,200,000
Present freight rate per bale to eastern seaboard		$3.50
Freight saving on cotton, if water route were available		$1,500,000
Annual crop of cotton seed (estimated)	tons..	376,000
Estimated value		$4,000,000
Freight saving on cotton seed, if water route were available		$1,128,000
Lumber marketed last season	tons..	4,750,000
Value of lumber shipped last season		$81,000,000
Taxable property in district		$82,880,000
Amount of freight paid all lines of transportation		$15,300,000
Amount of business transacted		$193,716,000

The competing lines of transportation are as follows: Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark.; by the St. Louis Southwestern Railway (Cotton Belt Route) at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis, Iron Mountain and Southern Railway has a branch line parallel to the river from El Dorado to Gurdon, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, Ark., the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction about midway between Bayou Bartholomew and Bœuf River, touches the Ouachita River, and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down, parallel to the main river, to Columbia, La., crossing at Riverton, 4 miles above Columbia, and runs thence to Alexandria, La. The Natchez, Red River and Texas Railroad (narrow gauge) runs from Black River Station, opposite Trinity, to Vidalia, La., on Mississippi River opposite Natchez, Miss. The New Orleans and Northwestern Railway is completed from Natchez, Miss., to near Bastrop, La., and crosses Tensas River near its mouth and Bœuf River about 2 miles north of Rayville, La.

U 5.

IMPROVEMENT OF BAYOUS D'ARBONNE AND CORNEY, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the south, middle, and north, or Corney branches, near Farmerville, Union Parish, northern Louisiana, flows in a southeasterly direction, and enters Ouachita River 6 miles above Monroe, La. The course of the bayou is very tortuous, through an alluvial bottom, varying in width from 1 mile at the head of navigation to 5 or 6 miles at its mouth, which is overflowed during high water to a depth of from 5 to 15 feet. In its windings the stream touches the hills at several places, which serve as shipping points for the country back of them.

An examination and a survey, directed by river and harbor act of 1882, were made in 1883, and the project for improvement was based upon the latter. The bayou is navigable only at high stages, and it was believed that by the removal of snags, logs, wrecks, and leaning timber from Stein Bluff, on the Corney Branch, to the mouth of the bayou, 42½ miles, the boating season would be lengthened two months and navigation made less hazardous at all times. The estimated cost of such improvement was $15,000, if spent in two consecutive seasons. (Report Chief of Engineers, 1884, pp. 1372–1381.) The act of 1892 provided that $1,000 should be expended for the improvement of Bayou Corney above Stein Bluff to the head of navigation, and the act of

1894 provided that $1,000 should be expended in removing obstructions from the Little D'Arbonne, or south branch.

The appropriations have been as follows:

By act of—	
July 5, 1884	$5,000
August 5, 1886	2,000
August 11, 1888	2,000
September 19, 1890	2,000
July 13, 1892	4,000
August 17, 1894	3,000
Total	18,000

The improvement was begun in the autumn of 1884; the first work (let by contract, at a cost of $197.50 per mile) commenced at the mouth, was carried upstream about 23 miles, and suspended December 11, 1884. This work having shown that the contract method was not well adapted to the class of work required and not the most economical means of carrying out the project, subsequent operations were conducted by hired labor. The appropriation of 1886 was expended that fall and the following summer in going over the lower 23 miles of the bayou and continuing the work upstream about 6 miles. In the summer of 1889 operations were resumed and carried up to Stein Bluff. In December, 1890, a chopping party was sent to go over the work, navigation having been reported much obstructed by fallen timber. Work commenced at Stein Bluff January 7, 1891, and was carried downstream about 9 miles, when rainy weather set in and operations had to be suspended on account of high water, and were not resumed to the end of that fiscal year. In August and September, 1891, the entire stretch from Stein Bluff to the mouth was worked over thoroughly at a low stage of water, and September 1 to November 25, 1893, a chopping party worked at the lowest stages from Cobb Landing, the head of navigation on Bayou Corney, down to Stein Bluff and thence to the mouth of D'Arbonne.

Considerable work had been done by steamboat men in the way of clearing leaning timber and removing the worst snags before the improvement was undertaken by the United States, and in 1883 Bayou D'Arbonne was reported navigable from six to seven months of the year. The removal of obstructions by the United States extended the period of navigation fully one month, enabled boats of double the capacity of those formerly used to make quicker time with less risk, reduced freight rates one-half, and extended the limit of navigation 16½ miles up the Corney Branch.

Nothing was done during the fiscal year ending June 30, 1895. In April Overseer J. R. Vaughan was sent to make an examination of the bayou and its branches with a view to resuming work, and reported as follows:

CHARLIEVILLE, LA., *April 24, 1895.*

CAPTAIN: I have the honor to report upon an examination of Bayou D'Arbonne and the Little D'Arbonne and Corney branches, made by me April 17 to 24, in accordance with your instructions of 13th instant.

The Little D'Arbonne was examined from Unionville to its junction with the Corney at Farmerville, the Corney Branch from Cobb Landing to Farmerville, and Bayou D'Arbonne from Farmerville to its mouth.

I found Little D'Arbonne to be comparatively straight and quite narrow (from 40 to 70 feet wide). There is no very heavy green timber to cut along its course; mostly scrubby cypress from 20 to 80 feet high and 4 to 12 inches diameter. A number of trees have been felled as foot logs across the stream, a great many have been cut for staves, whose tops have fallen in, reaching in places entirely across the bayou, and there are a number of stumps in the channel. I learned from old residents near the stream that in 1847 or 1848 the bayou was cut out by the State.

The Corney, from Cobb Landing to Stein Bluff, is crooked and obstructed by green trees standing on the points, and logs in the channel. Men who raft timber on this branch are responsible for the obstructed condition at many places. The stream being very crooked and swift, rafts hit trees on the points and are wrecked. I saw 700 or 800 logs on points or in bends along the stream.

Bayou D'Arbonne is in good condition, and little work is needed in it compared with the upper branches, especially the Corney above Stein Bluff. The wreck of the steamer *Helen Vaughan* (burned March 17, 1895), lies across the bayou, bottom up, about 4 miles above the mouth. The depth of water at her head was 18 feet, amidship 22 feet, and astern 18 feet. There were no fastenings, and the wreck seemed to be swinging with the current. I could not determine what held it in place, unless it was the weight of machinery. The wreck could easily be blown up as it lies, but Mr. Phillips told me the insurance company will not release it until the two months' time prescribed by law has expired or they sell it, as he has talked with their agents upon the subject.

With reference to resuming work for the improvement of these streams, I would respectfully suggest that it be deferred until later in the season, when all are at a low stage with reasonable probability of continued low water. Operations should begin at Unionville and be carried down to Farmerville, then the outfit should be hauled to Cobb Landing on the Corney, and work carried thence downstream to mouth of D'Arbonne. It being impossible to get a quarter boat up the stream at low water, if the funds were sufficient to build one, it is suggested that the work be done by a force of about 20 laborers who will subsist themselves. This labor can be hired along the stream at about $1.25 per day of eight hours.

Respectfully submitted.

J. R. VAUGHAN, *Overseer.*

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

On the 13th of April notification was sent the underwriters that the wreck of the steamer *Helen Vaughan* had been complained of as an obstruction to navigation, and if permitted to remain after May 17, 1895, it would be subject to be broken up and removed under section 8 of river and harbor act approved September 19, 1890. May 25, Watkins Decker, master of the snag boat *Wagner*, visited the locality to ascertain if the wreck had been removed. He reported that the underwriters had sold the wreck; that the hull had been floated out of the bayou into Ouachita River, and was tied up out of the way of navigation, and that the boiler and engines were in the bottom of D'Arbonne, but not obstructing navigation at the time. The owner was notified to remove the machinery, and if it is left in the way of passage of boats it will be destroyed when work is resumed.

Operations will be resumed this fall in accordance with the plan suggested by Overseer Vaughan April 24.

The work is not permanent, as new obstructions are added from time to time, but as the original project for benefiting high-water navigation has been completed, no estimate is made for continuing operations.

Money statement.

July 1, 1894, balance unexpended	$1,234.55
Amount appropriated by act of August 17, 1894	3,000.00
	4,234.55
June 30, 1895, amount expended during fiscal year	223.12
July 1, 1895, balance unexpended	4,011.43

COMMERCIAL STATISTICS.

The bayous were reported navigable from January 10 to end of the fiscal year. Cobbs Landing is considered the head of navigation on Bayou Corney, and Unionville on Bayou D'Arbonne.

List of stern-wheel steamboats engaged in navigating Bayous D'Arbonne and Corney in the fiscal year 1895.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Belle of D'Arbonne..	74.59	111.0	22.0	3.7	2 0	4 0	Monroe, Farmerville, and Cobb Landing.	17	48
Sam. Jones.....	25.00	70.0	14.0	.....	0 7	2 2	Monroe and Unionville.....	6	....
Rosa B.....	41.85	82.0	16.0	4.0	1 4	3 0	Monroe and Farmerville...	8	26
							Monroe and Shiloh.....	2	
Gasoline	14.00	80.0	9.0	2.0	0 7	1 10	Monroe and Farmerville...	47	....
							Monroe and Farmerville...	7	....
Lura	8.00	50.0	12.0	2.0	1 0	3 0	Monroe and Shiloh.....	1	....
							Monroe and Lawrence Ferry.	2	....
Helen Vaughan.....	85.95	100.5	25.0	4.2	1 0	3 6	No report; boat burned....	....	....

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	899	1,297	1,839	2,610	2,738	1,500	2,500
Cotton seed.....	542	637	180	.....	500	1,000	.....
Hides.....	50	.....	.....	.....	4	.....	5
Lumber (logs).....	110	4,500	16	1,123	9,000	10,250	.....
Cotton-seed meal.....	.....	200	250	150	.....	.....	.....
Staves	172	745	.....	10	.....	.....	.....
Miscellaneous.....	352	1,227	1,893	668	543	.....	.....
Total down freight.....	2,125	8,606	4,178	4,561	12,785	12,750	2,505
Return freight.....	1,268	888	1,324	1,697	1,187	1,666	1,670
Total.....	3,393	9,494	5,502	6,258	13,972	14,416	4,175
Estimated value.....	$189,000	$266,000	$440,000	$617,240	$683,500	$646,000	$500,000

The bayous are the only available means for transporting crops and supplies except by hauling long distances in wagons to the Vicksburg, Shreveport and Pacific Railroad on the south, to the branch railroad at El Dorado, Ark., or to Ouachita River.

U 6.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

Bayou Bartholomew has its source in Jefferson County, southeastern Arkansas, within a few miles of Pine Bluff, and, following a tortuous course, flows at first nearly parallel to Arkansas River, at a distance varying from 15 to 30 miles, then parallel to the Mississippi, at about the same average distance, but after entering Louisiana turns to the southwest and finally enters Ouachita River in Morehouse Parish, opposite Ouachita City. The total drainage area of the bayou and tributaries is about 1,800 square miles. The States of Louisiana and Arkansas made expenditures at various times for its improvement, navigation of the stream having been carried on to a considerable extent as early as 1843.

Examinations of the bayou were made in accordance with requirements of river and harbor acts as follows: From its mouth to the

Arkansas State line, act of March 3, 1871; from Baxter, Ark., to its mouth, acts of June 18, 1878, and June 14, 1880, and above Baxter to the Lincoln County line, Arkansas, act of July 5, 1884. Reports upon these examinations are contained in reports of the Chief of Engineers, viz: 1872, pages 383–386; 1879, pages 997–1003; 1881, pages 1453–1457, and 1885, pages 1548–1552.

The project for the improvement adopted in 1881 contemplated the removal of snags, logs, wrecks, leaning timber, etc, to give safe navigation from Baxter, Ark., to the mouth, a distance estimated to be about 150 miles. The original estimate of cost for two consecutive seasons' work was $26,862, but as new obstructions are added every year no estimate for permanent improvement has been made.

The following appropriations have been made:

By act of—		By act of—	
March 3, 1881	$8,000	September 19, 1890	$5,000
August 2, 1882	5,000	July 13, 1892	5,000
July 5, 1884	5,000	August 17, 1894	5,000
August 5, 1886	5,000		
August 11, 1888	5,000	Total	43,000

The work was commenced by hired labor July 20, 1881, at Baxter, Ark., and was carried downstream to Bartholomew, Ark., where operations were suspended December 25, 1881, by high water. Operations were resumed August 29, 1882, at the latter place, and were continued downstream to Lind Grove, La., and discontinued December 1, 1882, by high water. Owing to lack of funds nothing further was done until the appropriation of 1884 was made, when it was decided to give the contract system a trial upon this and other tributaries of Ouachita River. Contract was let for the removal of obstructions at $75 per mile, and work commenced at the mouth November 10, 1884, extended upstream 66⅔ miles, and was suspended December 7, 1884. Nothing was done the following year, as no appropriation was made, and operations were not resumed until November 20, 1886. The contract method having failed to prove satisfactory or economical to the United States, a chopping party commenced work at the mouth on the latter date and continued upstream until stopped by high water, January 20, 1887, at Point Pleasant, La. Operations were resumed July 25, 1887, at Poplar Bluff, Ark., and continued downstream to Point Pleasant, and suspended September 10, 1887, the funds being exhausted. Nothing further was done until August 6, 1889, when a chopping party commenced work at the mouth, continued upstream about 90 miles to Oak Landing, and there suspended operations November 21, 1889. In February, 1890, the U. S. snag boat *Hooker* made a patrol as high as Ohio Landing, Ark., about 118 miles above the mouth, removing jams of drift, etc. Operations were resumed by a chopping party May 11, 1891, at Portland, Ark., about 35 miles below Baxter, and carried downstream to the mouth, and suspended August 14, 1891. No work was done during the fiscal year 1893. August 1–October 31, 1893, work of a chopping party extended from McCombs Landing, Arkansas, some 30 miles below Baxter, considered the head of navigation, to the mouth.

From the foregoing it will be seen that operations from 1881 to the close of the fiscal year 1894 extended over that portion of the bayou included in the project, and that the worst stretches were worked over three and four times. This intermittent work benefited navigation to a considerable extent, rendering it comparatively safe at medium and high stages. The average duration of the navigable season before the

improvement commenced was three months; the work gave better navigation for about six months of the year, and boats of double the capacity of those used formerly made trips with greater safety in half the time. Freight rates were stated to be 50 per cent less.

Work during the fiscal year ending June 30, 1895, was as follows:

The U. S. snag boat *O. G. Wagner*, Watkins Decker, master, left Monroe, La., April 6, 1895, and commenced work at the mouth of the bayou April 8. Operations continued upstream to mouth of Chemin en Haut Bayou, a distance of about 55 miles, which point was reached April 20. The water had fallen so much by that time that the boat could not remain longer in the stream with safety, and it rounded to and returned to Monroe April 23. Although barely seventeen months had passed since this part of the bayou was worked over at a low stage, it was found much obstructed by caved-in trees, side jams which had formed above them, floating butts, and a few stumps and shore snags. At New Hope Bend and above Jones Landing caved-in trees were removed that stretched from bank to bank, and side jams were removed at the following places: Mount Maria Chapel, Farmer Place, Dr. Potts, Guthrie, Johnson Hall, Marble, Sandage, island below Point Pleasant, and Dr. Bonner's place. When the boat entered the bayou it was at 12 foot stage, but during the two weeks it was at work the water fell 8 feet.

The following is a summary of the work done, viz:

Snags pulled	94
Stumps pulled	7
Stumps cut	13
Shore snags cut	68
Side jams removed	10
Leaning trees removed	12

The removal of these obstructions left the channel clear at medium stages.

As soon as practicable a chopping party will be organized to work over the lower portion of the bayou at low water and to carry operations as far upstream as the available funds will permit.

In a heavily timbered stream like this bayou snags and drift are adding continually, and to maintain safe navigation at medium and high stages work will have to continue for years at the rate of appropriations in the past.

Money statement.

July 1, 1894, balance unexpended	$1,034.07
Amount appropriated by act of August 17, 1894	5,000.00
	6,034.07
June 30, 1895, amount expended during fiscal year	1,144.10
July 1, 1895, balance unexpended	4,889.97
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

Bayou Bartholomew was reported navigable from January 20 to May 1 in the past fiscal year.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Parlor City	Stern-wheel.	136.3	125	26	3.7	2 0	6 0	Monroe and Lind Grove, La.	1	
								Monroe and De Siard, La.	4	
								Monroe and Point Pleasant, La.	5	
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2 0	4 6	Monroe and Poplar Bluff, Ark.	7	60
								Monroe and mouth of Bearhouse Creek, Ark.	3	
Le Vere	Stern-wheel.	98.73	109.2	23.9	2.9	0 7	2 10	Monroe, La., and Portland, Ark.	20	

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	1,390	2,434	1,000	2,872	3,971	2,000
Cotton seed	3,836	2,991	1,300	3,326	2,467	4,000
Cotton-seed meal	.....	.....	.....	1,425	516	.....
Saw logs	.....	159	2,000	4,450	20,080	11,839
Staves	117	2,569	2,375	1,648	17,822	.....
Miscellaneous	100	665	175	410	1,340	.....
Total down freight	5,433	8,818	6,850	13,631	46,196	17,839
Return freight	1,200	3,469	825	1,534	3,103	4,000
Total	6,633	12,287	7,675	15,165	49,299	21,839
Estimated value	$243,000	$564,000	$136,000	$515,000	$826,000	$492,700

This stream is crossed at Baxter, Ark., the upper limit of improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City, Ark., runs west 56 miles to Warren, Ark., and probably will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurdon, Ark. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The New Orleans and Northwestern Railway has been completed to near Bastrop, La., and crosses the Houston, Central Arkansas and Northern Railroad at Kellars, La., 7 miles south of Bastrop.

U 7.

IMPROVEMENT OF BŒUF RIVER, LOUISIANA.

Bœuf River has its source in Chicot County, southeastern Arkansas, flows in a general southwesterly direction, and enters Ouachita River at Stafford Point, 8 miles above Harrisonburg, Catahoula Parish, La. The improvement of this stream was undertaken by the State of Louisiana more than half a century ago, the report of the board of public works in 1840 stating that it had been opened to Point Jefferson.

An examination was made in 1880, in accordance with requirements of river and harbor act of June 14, 1880 (Report Chief of Engineers, 1881,

pp. 1424–1428), and the project based thereon contemplated removing snags, logs, leaning timber, etc., obstructing navigation at high stages from Wallace Landing to the mouth, a distance estimated to be about 152 miles. The cost of removing the obstructions in two consecutive seasons was estimated at $20,000, but as new obstructions are added every year and require removal from time to time, no estimate for permanent improvement has been made.

River and harbor act of July 5, 1884, directed an examination of three outlets near Point Jefferson, La., with a view to closing them. The report thereon recommended the closure of the outlets as necessary to preserve navigation in the stream (Report Chief of Engineers, 1885, pp. 1545–1548), and this addition to the project was approved by act of 1886, which provided for "continuing improvement, and for closing Outlet Number One."

The following appropriations have been made:

By act of—		By act of—	
March 3, 1881	$5,000	September 19, 1890	$5,000
August 2, 1882	5,000	July 13, 1892	10,000
July 5, 1884	5,000	August 17, 1894	8,000
August 5, 1886	5,000		
August 11, 1888	6,000	Total	49,000

The improvement was commenced, by hired labor, at Point Jefferson in August, 1881, and work of a chopping party was carried downstream about 100 miles and suspended at the close of November, 1881, when the available funds were exhausted. Operations were resumed September 9, 1882, and between that date and December 20, 1882, the portion of the river above the railroad crossing near Girard, La., to Point Jefferson was worked over by a chopping party. Nothing further was done until appropriation was made by act of 1884, when it was decided to give the contract method a trial upon the tributaries to Ouachita River. On Bœuf River the work was let at $75 per mile. Operations commenced November 15, 1884, at the mouth, extended upstream 60 miles, and were suspended December 11, 1884. The next appropriation provided for continuing the improvement and closing Outlet No. 1, but after a reexamination it was found essential that all three outlets be closed, and, by uniting with the planters whose lands would be protected, this was done in 1887 and 1888, the proportion of cost borne by the United Stated having been $5,441.78. Outlet No. 1 was closed substantially, the second outlet was closed by a heavy dam, and the third by a low dam, which was all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. The removal of obstructions, by hired labor, was resumed November 8, 1888, and between that date and May 22, 1889, operations were carried from Point Jefferson to the mouth, but work was suspended from January 1 to April 25, 1889, by high water. The small balance available was expended in December, 1889, for operations of the snag boat *Hooker* in working over the 60 miles above the mouth. September 28 to December 12, 1891, a chopping party worked from the mouth up to a point 9½ miles above the Vicksburg, Shreveport and Pacific Railroad Bridge. November 13, 1893, to January 6, 1894, a chopping party worked at a low stage from the mouth up to Winter's place, about 10 miles above the Vicksburg, Shreveport and Pacific Railroad Bridge, putting that stretch in safe condition for navigation at any stage high enough to permit steamboats to run.

The total amount expended to June 30, 1894, was $34,795.27, which enabled steamboats to run to Point Jefferson at high stages with gr_ater

safety, and below the Vicksburg, Shreveport and Pacific Railroad Bridge they could safely navigate at any stage high enough to permit them to cross the bars, at a saving of at least thirty-six hours' time on the round trip.

The closure of the three outlets at Point Jefferson in 1887–88 gave immediate benefit to navigation by confining the flow to its natural course and by scouring the bars below, but during the overflow from Mississippi River in the spring of 1890, caused by breaks in the levees, all the dams were destroyed. As it is essential that all the outlets be closed substantially and at the same time, and as sufficient funds for the purpose have not been available at any time since the dams were destroyed, it was decided to defer the work until a specific appropriation should be made for rebuilding the dams. The estimated cost of the work required is $30,000. (See Report, Chief of Engineers, 1893, p. 2017.)

During the fiscal year ending June 30, 1895, work for the removal of obstructions to navigation was continued as follows:

A chopping party was organized at Girard, La., September 10, 1894, and between that date and November 17, 1894, the stretch of river above the Vicksburg, Shreveport and Pacific Railroad Bridge to Wallace Landing was worked over, at its lowest stages, under the supervision of Overseer J. R. Vaughan, and thoroughly cleared of all obstructions. On completion of this work the party worked from the bridge downstream to Charlieville, where the force was disbanded January 31, 1895, on account of a rise of the river. The water having fallen to a low stage, the party was reorganized and work resumed at Charlieville May 9. From that date to June 15 operations were carried downstream to Crosby place, about 7 miles above the mouth of Bayou Lafourche and about 63 miles above the mouth of Bœuf River. Heavy local rains had caused a rise out of Lafourche, and operations were suspended temporarily June 15 until this should run out, and had not been resumed at the close of the fiscal year.

The following is a summary of the work done during the fiscal year, viz:

Snags removed from channel	19,316
Shore snags removed	12,361
Logs cut and destroyed	14,234
Stumps cut and destroyed	9,614
Leaning trees removed	27,050
Trees girdled	34,399
Square yards willows and brush cut	48,021
Jams removed	6
Side jams removed	27
Linear feet brush dams built	1,830

Money statement.

July 1, 1894, balance unexpended	$6,204.73
Amount appropriated by act of August 17, 1894	8,000.00
	14,204.73
June 30, 1895, amount expended during fiscal year	8,498.03
July 1, 1895, balance unexpended	5,706.70
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	30,000.00

COMMERCIAL STATISTICS.

Bœuf River was reported navigable February–April in the past fiscal year.

List of steamboats engaged in navigation during the fiscal year 1895.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Parlor City	Stern wheel.	136.30	125	26	3.7	2 0	6 0	Monroe and Mrs. Jordan's.	14	25
Sterling White	Side wheel.	117.09	120	30.5	4.2	2 0	4 6	Monroe and Alto	1	....
Belle of D'Arbonne	Stern wheel.	74.59	111	22	3.7	2 0	4 0	Monroe and Girard.	1	....
								Monroe and Moon's.	1	....
Irwin (towing barges).	Tug							Tri-weekly trips from Stafford Point at mouth.		
Julia H. (towing barges).	do	4.88						do		
Joe (towing barges)	do	18.07	44.5	10	4	5 6	5 9	New Orleans and Bœuf River.	1	....

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	876	900	626	1,583	1,760	1,397	1,084
Cotton seed	2,313	2,550	1,878	1,178	716	731	834
Hides and skins	1			50			
Live stock	76	12		19			
Lumber	75	300	250	1,352			
Saw logs				1,223			
Staves	1,389	4,626	923	3,138	1,777	263	54
Miscellaneous	136	450	300	72	179		91
Total down freight	4,866	8,838	3,977	8,615	4,432	2,391	2,063
Return freight	250	650	335	1,370	3,458	1,594	1,376
Total	5,116	9,488	4,312	9,985	7,890	3,985	3,439
Estimated value	$159,000	$350,000	$200,000	$501,000	$636,500	$580,850	$457,100

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the New Orleans and Northwestern Railway crosses about 2 miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a line is projected (Louisiana, Arkansas and Missouri Railroad) which will touch the river at several points on the east.

U 8.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

Tensas River has its source in Lake Providence, in northeastern Louisiana, within 2 miles of the Mississippi River, flows in a general southerly direction, gradually diverging from the Mississippi, and joins Ouachita and Little rivers at Trinity, La., in forming Black River. Bayou Maçon was united under the same head of appropriation with Tensas River by the act of 1884. This stream rises in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles

west of the Mississippi, flows in a general southerly direction west of and nearly parallel to the Tensas, and enters the latter about 40 miles above its mouth.

In accordance with river and harbor act of June 14, 1880, examinations of both streams were made in 1880, upon which the plan for their improvement is based. The project contemplated removing snags, logs, and leaning timber obstructing navigation, in Tensas River, from Dallas, La., to its mouth, about 134 miles, at an estimated cost of $23,000; and in Bayou Maçon, from Floyd, La., to its mouth, about 98 miles, at an estimated cost of $17,000. (Report Chief of Engineers, 1881, pp. 1457–1467.) The estimates were based upon calculations for continuous work in one low-water season, and, in view of the appropriations made, are without value, as new obstructions are added every year and require removal in the interest of safe navigation from time to time.

The following appropriations have been made:

By act of—	
March 3, 1881	$3,000
July 5, 1884	4,000
August 5, 1886	4,000
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892	5,000
August 17, 1894	5,000
Total	31,000

The improvement of Tensas River was commenced by hired labor in September, 1881, at Dallas, La., where the Vicksburg, Shreveport and Pacific Railroad crosses the river; work was carried downstream to near Buckner Place and suspended the latter part of December, 1881. The next work was let by contract, at the rate of $125 per mile; operations commenced at the mouth October 29, 1884, were carried upstream about 29 miles, and suspended November 28, 1884. The contract method failed to prove satisfactory or economical for the class of work required in these streams, and subsequent operations were conducted by hired labor. As no work had been done in Bayou Maçon, the appropriation of 1886 was applied to that stream. Operations commenced November 14, 1886, and were suspended the latter part of January, 1887, work during this period having extended from Floyd to the mouth of the bayou. In October, 1887, this work was gone over from Floyd down to Oakley, about 22 miles above the mouth, operations consisting chiefly of the destruction of accumulations of drift, most of which was burned. Work was resumed February 1, 1889, and continued until April 22, 1889, extending over the entire portion of Bayou Maçon included in the project and about 25 miles of Tensas River between Mound Bayou and Tensas Bluff. The wreck of the steamboat *H. J. Dickey* was removed from Bayou Maçon, near Delhi, La., December 17, 1891, and from December 29, 1891, until January 12, 1892, a chopping party was employed in removing obstructions, chiefly in the channel, from the lower 40 miles of Bayou Maçon, work having been stopped the latter date by high water. August 22–December 22, 1892, a chopping party worked over Bayou Maçon from Floyd down to Oak Bluff Bayou, about 16 miles above the mouth, where operations were suspended by high water. December 11, 1893–January 30, 1894, Tensas River was worked over from its mouth up to Tensas Bluff, ordinarily considered the head of navigation, but the limited amount of funds permitted the removal of the worst obstructions only.

During the fiscal year ending June 30, 1895, operations were continued as follows:

September 7–11 the quarter boat which had been laid up in Tensas River at New Light, La., since January, 1894, was dropped down to the mouth of Bayou Maçon, where work commenced. In the succeeding two months operations were carried upstream to Floyd, which was reached November 9. November 10–28 the quarter boat was dropped downstream, to work in Tensas River above mouth of the Maçon, where the party was employed until January 16. Operations in Tensas River extended upstream to the Westwood Place, about 50 miles above the mouth of Bayou Maçon.

The work was done by a chopping party, using high explosives for destroying stumps and heavy snags, etc., and was carried on under the supervision of overseer F. L. Baugh until December 10, when he was relieved by overseer Robert Elflein, who remained in local charge until operations were suspended. The streams were near a low-water stage the entire season, and effective work was done, as shown by the following summary:

Obstructions destroyed.	In Bayou Maçon.	In Tensas River.
Snags removed from channel	1,327	499
Stumps removed	4,330	2,504
Shore snags cut	6,604	1,082
Logs removed from channel	340	130
Jams removed	7	1
Side jams removed	17	.....
Leaning trees cut	2,349	5,828
Leaning trees topped	745	77
Trees girdled	755	496
Mud lumps destroyed	4	6
Fish traps destroyed	.....	1
Drift piles removed	.....	1
Square yards willows and brush cut	.....	10,930

This work put Bayou Maçon, below Floyd, and Tensas River below Westwood Place, in good navigable condition for the present, and the felling of leaning timber will reduce the source of future obstructions considerably.

Money statement.

Amount appropriated by act of August 17, 1894	$5,000.00
June 30, 1895, amount expended during fiscal year	4,776.62
July 1, 1895, balance unexpended	223.38
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	9,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The river and bayou were reported navigable January–March, 1895.

List of stern-wheel steamboats engaged in navigation of Tensas River and Bayou Maçon during fiscal year 1895.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Danube	232.32	175	33.8	5.1	2 0	5 0	New Orleans and New Light on Tensas and Warsaw on Maçon.	8	30
Laura Blanks	62.73	104.8	21.3	3.8	1 6	3 6	Trinity and Floyd on Maçon	30	....
Marcus Collins	48.14	90	17	2.5	1 1	2 6	Trinity and Kirks Ferry	40	....
Marco	43.90	104.3	19	2.6	1 8	3 0	On Bayou Maçon: Jonesville and Dickeyport	2	....
							Jonesville and Egypt	1	....
							Jonesville and Delhi	2	....
							Jonesville and Floyd	1	....
							On Tensas River: Jonesville and Jordan	2	3
							Jonesville and Choctaw-Bayou.	2	....

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	1,543	450	498	3,762	2,760	1,527	2,750
Cotton seed	2,993	1,400	1,457	4,876	4,850	2,920	4,000
Hides and skins	50	2	3	.....	10	2	5
Live stock	290	108	3	10	6	.....	225
Staves	260	895	26	71	1,032	3,325	3,500
Lumber	4,012	300	.....	440	.....	.....	.....
Miscellaneous	1,045	104	.....	1,942	378	50	1,823
Total down freight	10,193	3,259	1,987	11,101	9,036	7,824	12,303
Return freight	2,092	2,700	662	5,886	6,000	5,216	8,202
Total	12,285	5,959	2,649	16,987	15,036	13,040	20,505
Estimated value	*$561,000	$389,000	$122,500	$990,000	$999,500	$742,390	$1,194,100

* The low price of cotton makes the value small in comparison with tonnages and values of former years.

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La. The New Orleans and Northwestern Railroad crosses Tensas River near Daniels Ferry, Concordia Parish, La.

U 9.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

Big Black River has its source in Webster County, Miss., flows in a general southwesterly direction, and enters Mississippi River at Grand Gulf, 37 miles below Vicksburg, having a length estimated to be about 400 miles.

Under river and harbor act of March 3, 1881, an examination of this stream was made, and the project submitted for its improvement contemplated two seasons' work in clearing a channel suitable for navigation at high stages of water by the removal of snags, logs, leaning

timber, etc., from Cox Ferry to the mouth, about 130 miles, at an estimated cost of $32,000.

The following appropriations have been made:

By act of—	
July 5, 1884	$5,000
August 5, 1886	5,000
July 13, 1892	5,000
Total	15,000

The first appropriation was expended in 1884–85, when a chopping party removed the principal obstructions for a distance of about 75 miles above the mouth.

The act of 1886 required that no part of the appropriation should be used until the State of Mississippi caused the bridges below the Vicksburg and Meridian Railroad to be so constructed as not to obstruct navigation. The bridges referred to were a county bridge at Baldwin Ferry, about 70 miles above the mouth; a county bridge at Ivanhoe Ferry, about 50 miles above the mouth, and the Louisville, New Orleans and Texas Railway Bridge, about 15 miles above the mouth. The fixed railway bridge was changed to a swing bridge in 1889, in accordance with an act of the State legislature; the Ivanhoe Bridge was replaced by a ferry in 1887, and the fixed wooden bridge at Baldwin Ferry was replaced in 1892 with a permanent iron swing bridge.

The river and harbor act of 1890 removed the restriction contained in the act of 1886 and authorized the expenditure of the appropriation. The project was modified to include only that part of the river below the Baldwin Ferry Bridge, and in 1891, a snag boat and chopping party were employed on that stretch. The principal work done was between Baldwin and Ivanhoe ferries, a distance of about 20 miles.

No work having been done since June, 1891, Overseer Watkins Decker was directed in August, 1894, to make a preliminary examination of the stream for the purpose of determining where and how the balance available could be expended to greatest advantage. His report is given below:

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., August 22, 1894.

CAPTAIN: According to your instructions, I have made an examination of Big Black River, to determine the best plan of expending the funds available for its improvement, and have the honor to submit the following report:

I proceeded from Vicksburg to Baldwin Ferry by wagon August 17, hauling a skiff. August 16 and 17 heavy rains fell in the locality of Big Black River and caused it to rise some 8 or 10 feet. It began falling on the 18th and continued to fall during my examination. August 18 I made an examination a short distance above and below the Baldwin Ferry Bridge, and August 19 started from Baldwin Ferry down the river in a skiff and arrived at the mouth at 10 o'clock a. m., August 21, estimated to be a distance of 70 miles. I found all of the river I examined in a badly obstructed and dangerous condition. The channel is obstructed with jams, side jams, slides, caved-in trees, snags, stumps, and logs; and along the banks are leaning trees, stumps, logs, and shore snags. I found between Baldwin and Highlander ferries 13 jams, varying from 50 to 400 feet in length, entirely blockading the river. In making the trip I had to pull the skiff over or around these jams. There are other partial jams, which I worked the skiff through easily at the stage of water, which I was informed was 6 to 8 feet above low water at Baldwin when I started. But if the water was down to its lowest stage a skiff would have to be pulled over or around them.

The stream from Baldwin down to Hankinson is very narrow, and the banks are lined with leaning willows, dangerous shore snags, and stumps. While there are a great many leaning trees along the banks below Hankinson, the stream is wider and so many of them will not have to be cut. There are no jams below Hankinson, but there are two slides which will obstruct navigation at a 20-foot stage of water. Numerous side jams are found, and a great many caved-in trees that reach from bank to bank.

Snags and stumps are so thick in the channel that a person passing down with a skiff has great difficulty in steering clear of them. The channel presents the picture of an old deadening that has stood long enough for the limbs and tops of the trees to have fallen off. The least water I found on the trip was 4 feet. This was about half way between the Yazoo and Mississippi Valley Railroad Bridge and the mouth. The snags and stumps at this stage stand 10 to 15 feet above the surface of the water, making navigation dangerous at a 15 to 20 foot stage. In the narrow portion the tops of the trees overhanging from each bank only lack 4 to 5 feet of touching. The banks slide badly after every rise, and I take it that the snags and stumps in the channel are the result of slides; the tops of the trees on the slides having been cut or broken off in former years.

By removing channel obstructions at a low stage of water, and cutting leaning trees, a small boat could navigate the stream at a much lower stage than formerly, and probably would carry out some cotton and nearly all of the cotton seed raised along the stream. It would be impracticable to attempt to make safe low-water navigation, for the reason that the cost would far exceed the value of any benefit that might be derived. Any improvement of low-water navigation would not be permanent, on account of caving banks, and the cost of maintaining it, if once secured, would be nearly if not quite as much as the first cost every two or three years.

The funds available should be expended between Baldwin Ferry and the mouth, in removing channel obstructions and cutting leaning timber, stumps, and shore snags, to allow boats to navigate the stream at a high or medium stage of water. It is not believed that boats could be induced to go above Baldwin if the stream was cleared out.

I respectfully submit the following plan of operations:

A small flatboat should be built for use as a storeroom and cook house, the laborers to be quartered along the bank in tents. This boat can be built at Hankinson Ferry, as there is a sawmill about 1 mile from there that will furnish the lumber cheaper that it can be delivered from any other point. This boat should be 30 feet long and 14 feet wide. When completed, it should drop downstream a few miles below the Yazoo and Mississippi Valley Railroad Bridge, begin work at the old mouth of Big Black and carry it upstream to Baldwin Ferry, if possible. It would be impracticable to work from Baldwin Ferry downstream, on account of the jams. The smaller channel obstructions should be cut to low-water surface and the larger ones destroyed with explosives. The banks should be well cleared of leaning timber, stumps, and shore snags. When the timber is cut from the banks it will lessen the number of slides. Most of the trees are willow, and will float out the first rise. A force of 25 to 30 laborers should be employed, and a large amount of explosives used. Subsistence and other supplies should be purchased at Vicksburg and hauled to the work.

Respectfully submitted.

WATKINS DECKER, *Overseer.*

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

Construction of a flatboat for use on this work was commenced at Hankinson Ferry September 7 and completed September 22, 1894. A chopping party was organized September 17, under Overseer John Schuh, and employed in vicinity of Hankinson Ferry until the boat was finished, after which it was moved downstream to the mouth. Work was continued until December 15, when the funds ran out, and was carried from the mouth upstream to McKay Creek, a few miles below the Baldwin Ferry Bridge. During the entire period the water was near an extreme low stage and the conditions were most favorable for work. Progress was slow, as the obstructions were heavy and numerous, and much difficulty was had in moving the light flatboat upstream, on account of the bars, jams, tree slides, and logs in the channel.

The following is a summary of the work done, viz:

Channel snags removed	17,480
Stumps removed	6,540
Shore snags removed	5,608
Logs destroyed	195
Old piles removed under railroad bridge	6
Jams removed	33
Side jams removed	41

Leaning trees removed	24,630
Leaning trees topped	358
Trees girdled	41,922
Square yards willows and brush cut	1,059
Cubic yards stone blasted from channel	13

Wrecks removed, viz, old ferryboat below McCay Ferry.

This work put the river from Baldwin Ferry to the mouth in fair condition for navigation at stages high enough to permit boats to cross the bars, but will not be permanent, on account of caving banks and drift brought down from above. Incidentally it will benefit the lowlands along the stream by permitting it to carry off the floods more rapidly, reducing the duration and height of freshets.

The following extract from former reports is repeated, viz:

In view of the small amount of commerce in this stream, the fact that there is no probability of an increased business for years to come, and the cost of maintaining unobstructed navigation by the removal of snags and drift and leaning timber added every year, it is not believed that any further amount can be expended profitably in continuing the work, and for this reason no estimate is submitted.

Money statement.

July 1, 1894, balance unexpended	$4,804.97
June 30, 1895, amount expended during fiscal year	4,804.97

COMMERCIAL STATISTICS.

No commerce or navigation was reported for the fiscal year 1895. Some timber was rafted, and one small steamboat was said to have gone into the river, but no details of tonnage, etc., could be obtained.

U 10.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 173 miles long, is formed by the junction of Tallahatchee and Yallabusha rivers, in Leflore County, Miss., flows in a general southerly and then southwesterly direction, and enters Mississippi River 5 miles above Vicksburg.

An examination was directed by river and harbor act of June 10, 1872, with a view to removing wrecks of gunboats, steamers, and other obstructions placed in the river to bar navigation during the war, report upon which was made the following year. (Report Chief of Engineers, 1873, pp. 483, 484.) In 1874 a further examination was made, and estimates were submitted for thoroughly clearing the river of obstructions in a period of four years, at a cost of $120,000; small annual appropriations to be made thereafter for maintenance. (Reports Chief of Engineers, 1874, Part I, pp. 364–367, and 1875, Part I, p. 522.) The appropriations made were not sufficient to carry out this project, and the plan under which work has continued since 1875 contemplates the removal of wrecks, snags, logs, leaning timber, etc., obstructing navigation, so far as the funds provided from time to time will permit. Floods, sliding and caving banks, etc., add new obstructions, and the work should be gone over yearly in the interest of safe navigation.

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1873	$40,000	July 5, 1884	$10,000
March 3, 1875	12,000	August 5, 1886	15,000
August 14, 1876	15,000	August 11, 1888	32,000
June 18, 1878	25,000	September 19, 1890	25,000
March 3, 1879	15,000	July 13, 1892	20,000
June 14, 1880	12,000	August 17, 1894	20,000
March 3, 1881	6,000		
August 2, 1882	8,000	Total	255,000

The first appropriation was applied in 1873–74 to the removal by contract of wrecks of nine vessels sunk during the war of the rebellion. After newspaper advertisement of fifty days, only two proposals were received, and the contract was awarded the lowest bidder for the sum of $35,450. Experience gained by this work showed that the improvement could be continued more economically by means of a snag boat owned and operated by the United States. In 1875 and 1877 the U. S. snag boat *O. G. Wagner* was used for the purpose, but since the completion of the snag boat *John R. Meigs*, in 1879, the principal work has been done by that vessel.

The total amount expended to June 30, 1894, was $232,536.87. The result of the work done was marked; the large number of wrecks that obstructed the channel and limited the period of navigation were removed so as to present little or no obstruction, and the removal of snags, logs, leaning timber, etc., repeated from time to time, gave steamboat navigation from head to mouth the year round, the only obstacle of importance being the shifting bar at the junction with the Mississippi, which prevented loaded vessels entering or leaving at low stages.

In the fall of 1894 the machinery of the snag boat *Meigs* was overhauled and repaired, and the boat put in readiness for work when needed. Operations were not resumed during the fiscal year ending June 30, 1895, as no complaints were made by the steamboats, and it was deemed advisable to reserve the available funds for work during the coming fall, when there is a probability of continued low water, and it can be prosecuted to greatest advantage.

The recommendations and estimates contained in my last report are repeated, viz:

Work in Yazoo and tributary streams could be carried on more economically if they were grouped together as a system and appropriations made under one head, with allotments for each stream. The plant could then be bought from the general appropriation and its use charged pro rata without being a heavy burden upon any one stream. A modern dredge, preferably self-propelling, would be of great use in parts of Yazoo, Tchula Lake, and Big Sunflower, but the largest appropriation of late years for any one of the streams mentioned would not be sufficient for the purpose. So also with regard to pile drivers, quarter boats, or small, hand-snagging outfits, the idea being to have a district plant, to be used on any of the streams of the system when needed. The estimates are made with this view, the work required not being of a kind that can be done advantageously or satisfactorily by contract. A great deal of work remains to be done in clearing the banks of leaning timber to prevent tree slides and snags, and to make the passage of the sharp bends safer, and this can be done most economically by shore parties housed and subsisted on quarter boats, leaving the heavy work to be done at the proper or convenient time by the snag boats. There are also many places where the channel is injured by dispersion, and where chutes should be closed or wing dams built. As Yazoo and tributaries are not subject to heavy drift, work of the kind need not be expensive, and probably sheet piling would answer very well.

DETAILED ESTIMATES.

General service plant:		
Dredge	$30,000	
Pile driver	4,000	
Quarter boats	2,500	
Skiffs, tools, rigging, etc	3,500	
		$40,000
Service of plant:		
Expenses of snag boats	24,000	
Expenses of dredges	9,000	
Expenses of shore parties	7,000	
		40,000
Care of plant:		
New boilers	4,000	
Hull repairs	3,000	
General and extraordinary repairs	1,500	
Fleet, wages, supplies, etc	1,500	
		10,000
Surveys:		
Local surveys, gauges, discharge measurements, etc		6,000
Administration:		
Office expenses, rent, supplies, etc	1,500	
Assistant engineers, draftsmen, transportation, and incidentals	2,500	
		4,000
Total		100,000

Money statement.

July 1, 1894, balance unexpended	$2,463.13
Amount appropriated by act of August 17, 1894	20,000.00
	22,463.13
June 30, 1895, amount expended during fiscal year	3,959.19
July 1, 1895, balance unexpended	18,503.94
July 1, 1895, outstanding liabilities	15.05
July 1, 1895, balance available	18,488.89
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	100,000.00

COMMERCIAL STATISTICS

The river was reported closed to navigation by the bar at the mouth from July 31 to October 5, 1894. Above the mouth it was navigable its entire length the whole year.

List of steamboats engaged in navigating Yazoo River during fiscal year 1895.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Blanks Cornwall	Stern-wheel.	232.4	140	29	4.6	2 2	5 2	Vicksburg and Greenwood.	49	635
Hibernia	do	157.06	135	25	4	2 6	4 0	Vicksburg and Belzona.	47	476
Des Arc	do	40.88	95	18	3	1 2	3 0	Yazoo City and mouth Big Sunflower River.	25	97
Birdie Bailey	do	109.7	111	22	3.5	1 10	4 0	do	150	1105
John F. Allen	do	133.9	130.2	24	4.2	1 8	4 0	Vicksburg and Greenwood.	32	163

List of steamboats engaged in navigating Yazoo River during fiscal year 1895—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Fifteen	Stern-wheel.	75	103	18	3.5	1 8	3 0	Vicksburg and Greenwood.	36	163
H. M. Townsend (towboat).	..do	87.7	116.7	18.	3.1	.....	.....	New Orleans and Greenwood.	1	.....
White Oak *	Tug	31.32	69	13	6.4	5 6	8 6	New Orleans and Yazoo River.	1	.....
								Greenwood and mouth.	2	.....
Jennie Campbell (towboat).	Stern-wheel.	225.06	144	26.5	4	.....	.....	New Orleans and Coldwater River.	1	.....
John L. Lowry	..do	54.15	108	16	3.6	1 8	2 4	Vicksburg and Big Sunflower River.	7	.....
Novelty	.. do	63.4	76.4	16.4	3.0	1 3	3 6	Vicksburg and mouth Big Sunflower River.	22	66
Crown Point	..do	159.14	123	25	4.2	1 8	5 0	Vicksburg and Big Sunflower River.	14	.....
Ed. Durant, jr.*	..do	153.49	113.6	29.6	4.6	1 8	3 6	New Orleans and Yazoo River.	1	.....
E. A. Pharr	..do	63.61	90	29.9	4.2	1 10	3 6	Greenwood and Shepherdstown.	1	.....
Joe Seay *	Tug	27.74	75	16	6	7 0	8 0	Vicksburg and mouth old river.	16	.....
Joe *	..do	18.07	44.5	10	4	5 6	5 9	General towing between Vicksburg and points on Yazoo River.		
J. B. O'Brien *	..do	44.49	70.8	15.2	7	8 0	10 0	Yazoo City and mouth Big Sunflower River.	3	.....
Yazonia	Stern-wheel.	62.84	.....	.....	.....	1 6	3 6	Yazoo City and Big Sunflower River.	103	977
Ferd R	..do	45.5	93	16	3	1 6	2 6	Irregular trips Greenwood and Tallahatchee River.		
Maggie	..do	.....	.....	.....	.....	1 5	3 6	Yazoo City and Big Sunflower River.	75	489
								Vicksburg and Big Sunflower River.	4	
Mima	..do	62.72	66	17	3.2	1 2	2 6	Vicksburg and Big Sunflower River.	4	

* With barges.

Summary of commerce reported.

Articles.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	17,037	15,815	11,094	15,653	13,750
Cotton seed	19,432	17,355	12,795	16,570	12,500
Hides and skins	11	10	26	19	10
Live stock	47	60	79	124	60
Lumber	10,080	3,200	3,122	3,318	3,600
Staves	10,623	14,447	12,488	6,864	1,350
Provisions	13,325	12,020	8,547	10,502	9,020
Grain	13,760	14,280	6,107	12,531	11,080
Saw logs	11,000	22,400	11,800	15,000	2,140
Miscellaneous	17,725	12,200	8,507	12,624	10,540
Total freights for Yazoo proper	113,040	111,787	74,565	93,205	64,050
Total freights from tributaries	107,551	136,394	124,887	116,021	97,588
Total freights Yazoo and tributaries	220,591	248,181	199,452	209,226	161,638
Estimated value	$4,806,000	$8,314,000	$4,329,000	$7,351,500	$6,315,275

The Georgia Pacific division of the Southern Railway crosses Yazoo River at Fort Loring, 5 miles below Greenwood, and the Yazoo and Mississippi Valley Railroad crosses about 15 miles above the mouth. The latter has a branch from Clarksdale to Minter City, on the Tallahatchee, connecting with a branch of the Georgia Pacific to Greenwood. The Yazoo branch of the Illinois Central Railroad, from Parsons on the Yallabusha to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

U 11.

IMPROVEMENT OF MOUTH OF YAZOO RIVER AND HARBOR AT VICKSBURG, MISSISSIPPI.

The shifting bar at mouth of Yazoo River is the most serious obstruction to navigation of that stream and its tributaries, and boats that could make trips into the chief streams of the Yazoo Valley system (about 800 miles of navigable waterway) without hindrance are prevented at low stages from entering or leaving without lightering across the bar, and frequently navigation is closed altogether.

The river and harbor act approved September 19, 1890, provided the sum of $5,000 to "be used in making a survey of the Yazoo River from the bridge of the Louisville, New Orleans and Texas Railway to its mouth, for the purpose of determining in what manner the mouth of the river can be so improved as to freely permit the passage through the same, at all seasons of the year, of vessels engaged in the navigation of the river; and said survey shall also include an investigation into the feasibility and advantages of making a new mouth or outlet for said river, by way of Chickasaw Bayou, or otherwise, together with an estimate of the cost of the same."

The survey was made under my direction, and the report and maps were submitted February 4, 1892. My report was printed in House Ex. Doc. No. 125, Fifty-second Congress, first session, and reprinted in Report of the Chief of Engineers for 1892, Part II, pages 1627–1642. The project recommended contemplated the formation of a new outlet from the former mouth of Yazoo on Old River, through the deep water in Old River, across the low lands between Long and Barnett lakes to Lake Centennial, around the head of De Soto Island, along the front of Vicksburg, and entering the Mississippi River on the channel side at Kleinston. A basis of 2 meters below zero of the Kleinston gauge was given, so that the depth always should be sufficient for boats that can navigate Yazoo River at low water; the cut or canal from Old River to Lake Centennial was to be not less than 30 meters wide, with side slopes not steeper than 1 upon 2, unless it should be found better to cut full width for equal areas without regard to side slopes; and the greater part of the material excavated in digging the canal was to be put in Lake Centennial below head of De Soto Island, to make a solid filling for the new right bank across the west arm of the lake, which was to be revetted if found necessary. The West Pass of Lake Centennial was to be closed and filled to ordinary high water. Dredging was to be carried through Lake Centennial to Kleinston. Along the land cut small levees were to be built on each side at the limits of the right of way, and banks were to be built at the edges of the berme for footings for deposit of about one-third of the material excavated, to raise the low lands to grade and prevent dissipation of Yazoo into the swamp below and thence across to the lake and Mississippi River. A levee above highest floods should be built along left bank of Yazoo

River and down wrong end of Old River to join the levee and embankment on left bank of land cut. As Yazoo River fills in the lower section and scours as the rivers fall, it would continue to fill but cease to scour after the new mouth is opened, so that it seems probable that a dam will not be needed below the turn at head of Old River, and with this view the work of building such a dam was put last, with the expectation of omitting it altogether. The distance from old mouth of Yazoo River at head of Old River to Kleinston is 14.2 miles; by the new route it will be 9.2 miles. The original estimates of cost of the work, on a basis of completion in 3 years, amounted to $1,500,000, but were revised in my report for 1893 and the amount reduced to $1,200,000.

Appropriations have been made as follows:

Date of act.	Purport.	Amount.
July 13, 1892.....	Improving mouth of the Yazoo River, Mississippi, in accordance with plan of Capt. J. H. Willard, dated February 4, 1892, contained in House Ex. Doc. No. 125, Fifty-second Congress, first session, including borings and gauges.	*$75,000
August 17, 1894....	Improving mouth of the Yazoo River, Mississippi, continuing improvement, to be expended in accordance with plan of Capt. J. H. Willard, as set out in House Ex. Doc. No. 125, Fifty-second Congress, first session.	225,000
August 17, 1894....	Improving harbor at Vicksburg, Miss., not including work at Delta Point, La., continuing improvement under the direction of the Secretary of War.	40,000
	Total.....	340,000

*Should the Secretary of War be unable to obtain such right of way as may be necessary in the prosecution of this work, upon reasonable terms, by agreement, purchase, or voluntary conveyance, he he is hereby authorized to apply at any term of the circuit or district court of the United States for the western division of the southern district of Mississippi, and in the name of the United States institute and carry on proceedings to condemn such lands as may be necessary for right of way as aforesaid, and in such proceedings said court shall be governed by the laws of the State of Mississippi, so far as the same may be applicable to the subject of condemning private property for public use.

As the plan submitted in House Ex. Doc. No. 125, Fifty-second Congress, first session, contemplated dredging Vicksburg harbor to a depth of 2 meters below zero of the Kleinston gauge, in diverting the mouth of the Yazoo River by way of the new outlet, the appropriation for the harbor at Vicksburg must be applied to carrying out that plan, and the two items by act of August 17, 1894, treated in a single project.

The amount expended to June 30, 1894, was $13,915.21, and, with the exception of acquiring and clearing and grubbing the right of way for the land cut, the necessary preliminaries to beginning work were completed. The maps were finished on a scale of 1:5000, and a final line selected for the excavation between Old River and Lake Centennial, along which borings were made at intervals, extending below bottom grade of the cut proposed, and the character of the material determined. The locations and principal features of the borings and their characteristics are shown by the profile and table accompanying my last report. (Report Chief of Engineers, 1894, pp. 1494 and 1503–1505.) The material to be removed appears to be the same as that through which Yazoo River flows, and I have little doubt that the new route will change no more than the present river banks, except, perhaps, for a short distance where the line crosses an old river bed near Barnett Lake. There soft mud is found at full depth, and it may become necessary to make the cut much wider than intended, or perhaps shift the line somewhat to the northward to avoid it. Such change should make no material difference in the final cost.

The line of precise levels of the original survey from Kleinston to the Yazoo and Mississippi Valley Railroad Bridge near Redwood was

extended up the river to Yazoo City, thence along the railroad to Greenwood, near head of Yazoo River, and thence westward along the railroad to the permanent benches of the Coast and Geodetic Survey and Mississippi River Commission at Greenville, Miss., and discharge observations were made and computed.

To furnish a base for future levels on the west side of the dredged channel in front of Vicksburg, iron and vitrified pipes and marking points were set at intervals and connected with the system of levels, definite reference points having been established previously on the city side, as it was believed by many that the reduction in depth of channel in front of Vicksburg was due to deposit from Mississippi River during high water. Doubtless a portion of the fill in successive years after dredging operations had ceased was due to silting, but it is my opinion that the soft material on the sides of the cut ran in and also forced the bottom up as the weight was removed, not only by dredging but by the withdrawal of water as the river fell. Changes in elevations of pipes will show this, while the fill or scour may be determined from the fixed points on the Vicksburg front beyond the influence of the canal.

For the land cut between Old River and Lake Centennial, it was thought best on all accounts to have ample right of way, to give room for filling in with part of the spoil, and to allow for levee construction at a safe distance from edges of the cut. The cost of the lands required would be enhanced considerably if too small a width were taken at first and more should have to be purchased after work was established, and 1,000 meters was thought to be the *least* width prudent to allow for enlargement. This will require about 1,200 acres, more or less, the cost of which was estimated by me at not to exceed $30,000. I considered my duty limited to the engineering questions, and desired to have commissioners or an expert appointed to appraise the lands, who should be paid for their services according to section 404, Digest of Decisions of Second Comptroller, vol. 3, viz:

> Under an act which provides for the procurement of land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortification and coast defenses, the Secretary of War is not restricted to any particular method of acquiring the same, but can, at his discretion, engage the services of an expert in values of real estate and pay him a reasonable fee from the appropriation available for the procurement of such lands and rights.

My recommendation to this effect was disapproved, however, and I was directed to open negotiations with the land owners. Accordingly inquiry was made, the public records examined for names of owners, and letters sent inviting offers to give the lands or sell them at a fair price. The offers made were considered excessive, and letters again were sent, asking revised prices, and in the meantime an attempt was made to estimate the values of the lands from the tax lists, but as the taxes appeared to have been paid in gross, with deductions at times on account of overflows, they offered no bases for estimates. From the best information attainable, although at second or third hand, the offers generally were far in excess of the prices paid at latest transfers.

An act of the legislature of the State of Mississippi, approved February 2, 1894, authorizes the governor to cede jurisdiction to the United States over lands acquired for constructing levees, canals, etc., for improvement of rivers and harbors.

Operations during the fiscal year ending June 30, 1895, consisted chiefly of clearing and grubbing Vicksburg Harbor to full width, the bar at head of Lake Centennial, and the land along the proposed cut from Old River to Lake Centennial, details being given in the report of Assistant Engineer Marshall herewith.

In October, 1894, abstracts of title, prepared after careful examination of the county records, were completed and submitted for the opinion of the Attorney-General as to validity of titles, which was given February 5, 1895.

Definite offers, obtained from the owners of the lands to be acquired, were sent the Department June 22, 1895, and the purchase was authorized by the Secretary of War June 29, with exception of one tract, in which case certain complications connected with the title necessitate a resort to condemnation proceedings. The Secretary of War, on the 29th of June, also made request to the Attorney-General that the United States attorney for the southern district of Mississippi be instructed to prepare the necessary title papers for the land to be purchased, and to institute proceedings for condemning the remaining tract. It is understood that the date set for the condemnation proceedings is August 14, 1895, and it is hoped that the acquisition of all the lands, and cession by the State of jurisdiction over them, will be settled within the next few weeks.

Work in Vicksburg Harbor has been carried on under the Mississippi River Commission for some years, but was transferred to this engineering district as part of the general project for diverting Yazoo River "by way of Chickasaw Bayou or otherwise," although appropriated for by a separate item in the act of August 17, 1894.

Comparison of sections made before and after the successive dredging operations with the sections made for purpose of final estimates showed that the bottom always returned to about the same grade with respect to the Kleinston gauge, indicating either a fill by deposit or a sinking of the sides forcing up the bottom as the weight on the bed was reduced by the fall of the river surface. To avoid doing the same work over and over it seemed best not to begin on this part of the work until the lands should have been acquired and cleared, so that the work might be done as a whole so far as the funds would permit, whether by purchase of plant and hired labor or by contract. It was decided also not to attempt to go below the grade at which the bottom seemed to return after dredging, but to adjust the work so as to give the greatest width possible, economical depth for dredging being considered. If the opinion is correct that the rise of the bottom is due to weight on the sides of the cut, this method will be most advantageous, since it will remove the presumed cause of loss; for the silting up is not believed to be at all comparable in amount to that heretofore estimated. The delay on this part of the work for these reasons has caused some impatience on the part of those who are anxious for deep water in front of Vicksburg without delay, and who judge progress by the evidence of machines actually in operation. If the work under the Mississippi River Commission had been done with the full amount estimated, I have little doubt but that there would have been a basin of sufficient depth in front of Vicksburg, and a good channel to the Mississippi at Kleinston. But the appropriations were small and intermittent, and the prices under the successive contracts necessarily high to allow for loss of time and expenses in bringing dredging plant to Vicksburg and taking it to other work or home after funds were exhausted.

Section 2 of river and harbor act of September 19, 1890, provides—

That nothing contained in section 3717 of the Revised Statutes of the United States, nor in section 3 of the river and harbor act of August 11, 1888, shall be so construed as to prohibit or prevent the cumulation of two or more works of river and harbor improvement in the same proposal and contract, where such works are situated in the same region and of the same kind or character.

The delay on this part is fully justified by the facts, as understood, and the provision of the act just quoted will allow it to be let advantageously as part of the whole, for after providing for clearing the west side of timber and undergrowth and a reasonable amount for engineering contingencies, soundings, and measurement, the remainder of the specific appropriation would be too small to warrant low bids for the work as a separate section. It will be to the advantage of all parts of the work not to separate the appropriation into items, so that operations may be carried on in different portions according to the varying stage of river. On some accounts I believe it would be better not to begin excavation at all until the full amount is available, when the necessary plant may be bought or hired and the work done by day labor, or a contract made for doing the whole by continuous work, as may be judged most expedient. Still the total that may be applied to excavation probably will exceed $240,000, which should last with a liberal estimate for output until the next appropriation, if made during the coming session of Congress.

The original estimates were made for continuous work, and if this improvement were transferred to the list provided for in the act known as the sundry civil bill, I have no doubt that it can be done for less than the estimates, with the advantage of giving the benefit desired at a much earlier date than if the method of insufficient appropriations about once in two years should be continued.

The question now being considered is the advisability of doing a certain part of the land cut where the ground is highest by scrapers, so that the dredges may operate over the highest portions during high stages, entering as the water rises and withdrawing to the lower portions as it falls. Cutting down the high ground at the west end of the land cut near Old River and toward the eastern end near the old bank of the Mississippi River, now on the west side of Lake Centennial, to a grade corresponding to about 30 feet on the Kleinston gauge, would give a bottom grade about 18 feet below extreme high water, and thus prevent delays during the higher stages. This would require the removal of about 200,000 cubic meters, more or less, and to judge by the prices lately bid on levee work on Yazoo and Tensas fronts the expense should not be great. The cut should be about 120 meters wide at top, and the haul such as to leave a berm not less than 100 meters on either side. The spoil may be used to form small levees to inclose settling basins if the hydraulic method of dredging should be adopted, and afterwards in building the levees which are contemplated in the project. The question will be submitted to the Chief of Engineers for action at an early date.

The results of the borings indicate that there are no masses of logs or rock under the land between the lake and Old River, and that the material is without cohesion and of a character specially adapted to hydraulic dredging. With this method the output per engine hour should be large, and estimating from the work on the Chicago Drainage Canal, with due allowance for delays, moving, etc., not less than 100,000 cubic meters per month should be stipulated from a hydraulic dredge of 50-centimeter section pipe (say 18 to 20 inch machines as rated), through 300 meters of discharge pipe. By adjusting the position of the dredges to the stage of river the lift may be kept within reasonable limits, and under such favorable conditions the output may be increased perhaps 50 per cent or more.

The early completion of the large dredge for the Mississippi River Commission is awaited with interest, and it is hoped and believed that

the results will be of value in determining the best method to prosecute, and to decide the question as to the advisability of purchasing plant or of letting the work out under contract.

In clearing the lands a large amount of very heavy timber—oak, black gum, and pecan—was encountered, too heavy to be hauled out by team, and therefore it was decided to leave it, buoys being attached by wire, until the next high water, when the snag boats can tow it out. The lighter timber will have become thoroughly dried out and will float away on rising water, and can be collected and rafted by the same means and secured, to prevent forming jams in the channel. A considerable amount of timber has been cut into suitable lengths and cribbed, which which will be treated in the same way, except that it will be towed into place to form a line across Lake Centennial and weighted down by deposit of dredged spoil, to make the foundations of a dam in the lake.

Work in progress at the end of the fiscal year consisted in cutting a ditch from Barnett Lake into Willow Bayou to lower the lake surface and drain the contiguous land to permit the clearing and grubbing to go forward.

All of this work has been exceedingly heavy, and as it was of a kind difficult if not impracticable to do by contract, it is gratifying to know that it has cost less than estimated and very much less than the general estimates of contractors for levees. The work has been done in a broad-gauge way and explosives used liberally. The original estimates were $45 per acre for clearing and $450 per acre for grubbing. The expenditure thus far, and the heaviest part has been done, averages $193.15 per acre, as against $544.50 per acre under levee estimates of $125 per square (100-foot side). The explosives were graded according to the work to be done; the high explosives for splitting and destroying and the slower compound for upheaval. Laflin & Rand's magneto-batteries and standard platinum fuses have been used for ignition. It is also gratifying to be able to state that no accidents have happened.

Statement of cost of explosives used on the work:

Judson powder, 26,387½ pounds	$3,270.68
Dynamite, 7,794 pounds	975.78
Platinum fuses, 13,450	344.95
Total	4,591.41

A set of bromide prints,* from negatives taken with kodak, is appended, to illustrate the general character of the work.

The amounts expended during the year were:

For Yazoo River at mouth	$26,145.34
For harbor at Vicksburg	3,657.22
Total	29,802.56
The original estimate for the whole work was	1,500,000.00
The revised estimate of 1893, on basis of continuous work, was	1,200,000.00
Amount that has been appropriated	340,000.00
Balance required to complete	860,000.00

* Not printed.

Money statement.

July 1, 1894, balance unexpended	$61,084.79
Amount appropriated by act of August 17, 1894	265,000.00
	326,084.79
June 30, 1895, amount expended during fiscal year	29,802.56
July 1, 1895, balance unexpended	296,282.23
July 1, 1895, outstanding liabilities	589.99
July 1, 1895, balance available	295,692.24
Amount (estimated) required for completion of existing project	860,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	860,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. H. M. MARSHALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 29, 1895.

CAPTAIN: I have the honor to report on improvement of Yazoo River at the mouth and of Vicksburg Harbor, which are separate works in name only.

When the river had fallen last August to nearly zero on Kleinston gauge a party was sent to the mouth of Yazoo to take discharge, slopes, and soundings. Table 1 gives the results.

Property lines were traced on the ground, and the amount of land to be acquired from present proprietors, eight in number, was ascertained to be 495.55 hectares. Abstracts of all conveyances of record were prepared.

The base line and cross sections marked on the mud bar alongside the Vicksburg Harbor Canal, and leveled over in December, 1893, were releveled over December, 1894. The points had been marked by iron pins and elevations taken on top of the pins. Two hundred and ninety pins were found. The levels were run from permanent benches, and formed a system of loops within the work. There was no discrepancy in the levels greater than a centimeter, and the elevations of the points were accepted as correct without any adjustment. Table 2 and table 3 give the results arranged according to the differences in elevation, and location with reference to the base; in the former along the base or within strips parallel thereto, and in the latter within strips perpendicular to the base. The base was measured from the river and parallel to the canal about 180 meters from the edge of the top bank. It will be noticed that the bar sunk more and more as the distance from base increased, until the edge of the canal bank was passed, and that longitudinally the sinking was greater the farther the point from the present river bank. Small as the average sinking is, 24 millimeters, it is sufficient to account for 12,000 cubic meters gone from between the base and the canal within the year; yet during this interval no dredging was done. How far the sinking extended beyond the limits of the area leveled over is of course conjectural, and yet if the sum total of the sinking could have been ascertained it appears that it would not account for all the fill in the canal. For in the basin at the head of the canal the fill was least, while over the adjacent bar the sinking was greatest. The surface of the bar seems to have remained at about the same elevation since 1890, which proves that any sinking is made up for by a deposit. That the bar was formed by heavy annual deposits is of course well known, but that the rate was uniform, or that it is now anything like as much as formerly, appears quite unreasonable. The sections made from time to time, while dredging was going on subsequent to 1890, have been replotted and arranged so as to show to the eye the changes effected by the natural and mechanical forces at work. During the period 1891, 1892, and 1893, it is plain that while the dredging gained considerably in deepening the canal, in each interval between the working seasons a large part of the previous depth was lost, and there was no hope for a permanent depth. After dredging was abandoned the bottom soon returned to the condition which existed before, and is now about 4 meters above extreme low water. The material forming this bar is a fine silt, except on top and near the mouth of the canal, where it is sand, which when wet forms an ooze, and below the plane of permanent saturation flows in as the pressure is withdrawn by the fall in the water. A flowing

stream of water through the canal, if it has sufficient width and volume, will carry away this ooze, and gradually the settling bank will form an envelope preventing further inflow. No difficulty of this character will be encountered on the canal route from the head of Lake Centennial to Old River, except for a short distance through the flat bar at both ends.

Work in the field began this season in October. A base along the whole route has been measured with a steel tape, and reference points marked with vitrified pipe filled with cement set every 50 meters. Along the route between Lake Centennial and Old River these pipes have been set on both sides of the line 100 meters from the center line. Signs made of sheet iron with the section number painted on will be riveted to pieces of half-inch gas pipe and erected on poles at each reference point, so as to be above high water. These poles are made up of sections of gas pipe increasing in diameter with the height required.

Actual work of construction began in October with a small force cutting willows on the mud bar along the harbor canal. These willows were of several years' growth, and some were as large as 2½ decimeters in diameter. From year to year a deposit had made around the bodies, burying the limbs and inducing the growth of innumerable roots A tap root was thus made from 1 to 3 meters deep with a mass of lateral roots. An attempt was made to pull them up by means of a lever with block and tackle attached and four horses pulling on the hauling line. The power was multiplied one hundred fold, but failed to even loosen a stump, though a three-quarter inch chain broke repeatedly under the strain. Finally digging and blasting with dynamite and Judson powder were resorted to with success. The average cost of removing 1,878 stumps was 59 cents each.

After clearing and grubbing the harbor bar, work was continued between Lake Centennial and Old River. The timber was felled the entire distance and for 200 meters width. Of course through the cleared field next to Old River and through Barnett Lake, together about 1,200 meters in length, no cutting was necessary. Small limbs and tops were cut up and burned, and the bare tree trunks left to be floated away during next high water. It was anticipated that the heavy oak, gum, sycamore, etc., would not float, so cables of No. 9 wire were twisted around them and floats of light wood were attached, the cable being left long enough to reach above high water. As there has been no high water this year the tree trunks could not be moved.

Grubbing and blasting to get rid of the stumps was begun and prosecuted vigorously as soon as the felling was completed. About 2,500 willow stumps were destroyed on the mud bar at the head of Lake Centennial at a cost of 54 cents each. All stumps have been removed between Barnett Lake and Old River, a distance of 1,000 meters, save and except those within the banks of the lake where work can not be prosecuted until the lake is drained. Between Barnett Lake and the bar at the head of Lake Centennial the work has not been confined to contiguous sections because of water in the sloughs, but the equivalent of 600 meters in length has been grubbed, and there remain about 1,000 meters to be done in addition to 700 meters on the bar. In extent about half the grubbing is finished, but by far the heaviest portion is completed.

Each section is 1 hectare in extent, and the cost of the work per section is on an average as given below:

Felling timber	$30
Piling and burning	41
Grubbing	290
Blasting	119
Total	480

Very respectfully, your obedient servant,

H. M. MARSHALL, *Assistant Engineer.*

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

TABLE 1.—*Discharge observations in Yazoo River at mouth (current meter).*

Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface, Cairo datum — Discharge section.			Stage above low water, 1894.	Change in water surface per hour for previous 24 hours.
				2,850 meters above mouth.	360 meters above mouth.	At mouth.		Fall
1894.	*Square meters.*	*Meters.*	*Cubic meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*
Aug. 28	115	2.12	174	21.89	21.08	20.74	1.98	2.08
30	132	2.28	205	21.87	21.06	20.72	1.96	0.83
31	148	2.24	163	21.88	20.99	20.72	1.89	2.91
Sept. 3	134	2.27	165	21.88	20.99	20.73	1.89	0.00
4	139	2.12	156	21.87	20.98	20.73	1.88	0.41
5	132	2.20	166	21.85	20.98	20.73	1.88	0.00

TABLE 2.

Difference of elevation.	Distance from base line, meters.									Total.
	0.	0 to 25.	25 to 50.	50 to 75.	75 to 100	100 to 125.	125 to 150.	150 to 175.	175 to 206.7	
Meters.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Raised 0.19		1								1
0.12									1	1
0.09						1				1
0.08								1		1
0.07							1			1
0.05		1	1							2
0.03				1				1		2
0.02					1				1	2
0.01	1	3	4	1					1	10
Unchanged 0.00	6	8	4	6	8	4			1	37
Sunk 0.01	18	8	8	5	5	4	4	2	3	57
0.02	12	3	8	9	3	7	3	4	3	52
0.03	4	5	5	6	6	4	5	3	2	40
0.04		1	6	4	6	5	3	7	4	36
0.05			2	2	5	1	4	5		19
0.06						1		1	3	5
0.07					4	1	4			9
0.08									1	1
0.09					1	1		2		4
0.10						2				2
0.11			1			1		1		3
0.12						1		1		2
0.13									1	1
0.22				1						1
Mean sink, meters.	0.0129	0.0020	0.0192	0.0243	0.0290	0.0336	0.0325	0.0386	0.0262	0.024

TABLE 3.

Difference of elevation.	Distance from river, meters.							Total.
	50 to 300.	350 to 600.	650 to 900.	950 to 1,200.	1,250 to 1,500.	1,550 to 1,800.	1,850 to 2,100.	
Meters.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Raised 0.19			1					1
0.12					1			1
0.09					1			1
0.08			1					1
0.07					1			1
0.05					2			2
0.03	1				1			2
0.02	1				1			2
0.01	7	3						10

TABLE 3.—*Discharge observations in Yazoo River at mouth (current meter)*—Continued.

Difference of elevation.		Distance from river, meters.							Total.
		50 to 300.	350 to 600.	650 to 900.	950 to 1,200.	1,250 to 1,500.	1,550 to 1,800.	1,850 to 2,100.	
	Meters.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Unchanged	0.00	14	13	3	5	1	1	.....	37
Sunk	0.01	11	15	6	9	8	3	5	57
	0.02	4	6	11	12	13	4	2	52
	0.03	3	3	9	12	3	5	5	40
	0.04	1	2	7	5	9	10	2	36
	0.05	.....	1	3	1	3	6	5	19
	0.06	.....	.....	.....	1	2	2	.....	5
	0.07	1	.....	.....	1	3	.....	4	9
	0.08	.....	.....	.....	.....	.....	1	.....	1
	0.09	.....	.....	.....	1	1	1	1	4
	0.10	.....	.....	1	.....	.....	.....	1	2
	0.11	.....	.....	1	.....	.....	1	1	3
	0.12	.....	.....	.....	.....	1	.....	1	2
	0.13	.....	.....	.....	.....	.....	1	.....	1
	0.22	.....	.....	1	.....	.....	.....	.....	1
Mean sink, meters		0.0063	0.0107	0.0259	0.0247	0.0206	0.0426	0.0470	0.024

U 12.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Tchula Lake or River is the name given to the east and narrowest branch of the Yazoo River, where it divides in passing Honey Island. It is wholly within Holmes County, Miss., and is about 60 miles long. Honey Island is about 100 miles above the mouth of Yazoo River, and fertile plantations join each other along its banks, their annual product being estimated at about 20,000 bales of cotton. When the water is high enough to enable the Yazoo and Tallahatchee steamboats to cross the bars, they make trips through the lake.

In accordance with requirements of river and harbor act of March 3, 1879, an examination of the lake was made that year with a view to its improvement, and the principal obstructions to navigation were found to be snags and logs in the lower part, and leaning timber and shore snags along both banks, from the head to the foot of the island. The project contemplated removing these obstructions to permit light-draft boats to enter the lake earlier in the season, and the estimated cost was $10,000 if done in one low-water season. (Report Chief of Engineers, 1880, pp. 1350, 1351.) The work is of such nature that it must be gone over to remove obstructions that are added from time to time.

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1881	$3,000	September 19, 1890	$3,000
August 2, 1882	2,500	July 13, 1892	3,000
July 5, 1884	1,500	August 17, 1894	3,000
August 5, 1886	2,000		
August 11, 1888	3,000	Total	21,000

Operations have been carried on by hired labor. Work commenced at the head of the lake July 16, 1881, and was carried down to the foot, suspended September 8, 1881, and consisted of cutting and girdling leaning timber and removing the worst snags. It was resumed at the mouth, September 1, 1882, and carried up to the head of the lake, and suspended the middle of November, 1882. Nothing was done the following season, as no funds were available, but December 22, 1884, work

was resumed at the head of the lake and carried down to the foot, and suspended February 11, 1885. The next work was done by the U. S. snag boat *Meigs*, which was employed December 19–25, 1886, and April 11–30, 1887, in removing the heavier obstructions and clearing a good navigable channel 90 feet wide for a distance of 44 miles. February 1–19, 1889, the *Meigs* was employed again, and worked from the foot to the head of the lake and back, removing the heavier obstructions, after which operations were suspended until the water should fall sufficiently for a chopping party to commence clearing the banks, but as a favorable opportunity for advantageous expenditure of the small balance available was not presented during the following season, nothing was done until December 10, 1890, when the *Meigs* was used for the succeeding ten days in removing snags, tree slides, etc., from the channel. August 18, 1891, a chopping party commenced work at the head of the lake and continued downstream to Dunbarton, about 15 miles above the mouth, where it was suspended December 16, 1891, the available funds being exhausted. Operations during this period consisted of clearing the brush, which had grown so rapidly and to such extent that in many places the channel did not exceed 50 feet in width, cutting shore snags and logs, felling and girdling leaning timber on both banks, and removing snags from the channel.

This work gave greater ease and safety to navigation, but the period of navigation was not prolonged, owing to enlargement of bars in the lake.

In the fiscal year ending June 30, 1895, operations were continued as follows:

January 12–15, 1895, the quarter boat previously used in Big Black River, Mississippi, was towed by the U. S. steamer *Thos. B. Florence* from Vicksburg, Miss., to foot of the lake. A chopping party was organized and work commenced at once, under the supervision of Overseer John Schuh. January 15 to March 11 operations were carried from the mouth of the lake upstream to Graves Place, about 6 miles below the town of Tchula. High stages caused suspension of work March 12 to May 20, but, the water having fallen sufficiently, it was resumed the latter date and carried to head of the lake June 10. The lower portion of the lake, for about 15 miles, was found much obstructed by leaning trees, a heavy growth of willows and brush, the latter encroaching upon the channel until at places it was scarcely 40 feet in width, and by jams of drift. Above Dunbarton, where work was suspended in 1891, obstructions were not so heavy or numerous. From Stonewall to Richardson Landing, called the "nine-mile bend" (one-fourth mile across the neck), and above as far as Quafáloma the channel was narrow, having grown up with brush, and was obstructed by caved-in and fallen trees until it was difficult for steamboats to pass without damage to upper works or risk of raking freight off the guards. Fallen trees were destroyed with dynamite, leaning timber was cut and removed, the brush cleared, and the trees along the banks deadened, giving a good navigable channel in this stretch. From Quafaloma to Mileston less shore work was required, but snags and stumps were numerous. Above Mileston to Marcella the lake widens and shoals, the channel at low water being narrow, but at the stages at which boats run there is no difficulty in passing this stretch. Black Creek enters on the left, about a mile above Mileston, and a bridge which had come out of that stream on a freshet and lodged in the lake about 200 yards below was destroyed with explosives. From Marcella to a point about 2 miles above Tchula the lake generally is wide and deep with little current at ordinary stages, though rather crooked at

places, and in this stretch a great many snags and trees that had blown into the stream were removed. From the latter point to Oregon the stream narrows, with short bends grown up with small trees and brush, which were cleared. Where Horseshoe Bayou enters, on the right, two side jams were broken up and pulled ashore. Above the bayou to Linden the stream is narrow and was much obstructed by snags and logs. From Linden to Crescent it widens and makes a long bend of about 8 miles, and above Crescent to head of the lake, about 8 miles, it narrows again. Obstructions were numerous along this stretch. The lake at its head is connected with Yazoo River by a canal about half a mile long, as well as the natural channel, and as boats run through both at high stages they were thoroughly cleared of obstructions.

June 11 the party turned back, to work over the lake again, removing all obstructions passed on the way up, and at the close of the year operations had been carried down to Mileston.

The following is a summary of the work done during the year:

Snags removed from channel	4,752
Stumps cut and blown up	2,912
Shore snags removed	1,285
Logs cut and blown up	6,044
Jams removed	2
Side jams removed	21
Leaning trees removed	24,427
Leaning trees topped	71
Trees girdled	32,640
Square yards willows and brush cut	3,236

Wrecks removed, viz: Photographer's boat at Watson Landing February 23, and Black Creek bridge March 4.

The expenditure of the available balance should put the stream in safe navigable condition, so that further work will not be required for several years.

Money statement.

July 1, 1884, balance unexpended	$2,946.18
Amount appropriated by act of August 17, 1894	3,000.00
	5,946.18
June 30, 1895, amount expended during fiscal year	4,322.07
July 1, 1895, balance unexpended	1,624.11
July 1, 1895, outstanding liabilities	9.00
July 1, 1895, balance available	1,615.11

COMMERCIAL STATISTICS.

The lake was reported navigable January 15 to May 15, 1895.

List of stern-wheel steamboats that navigated Tchula Lake in the fiscal year 1895.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		From—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Blanks Cornwall	232.4	140	29	4.6	2 2	5 2	Vicksburg through lake	25	197
Des Arc	40.88	95	18	3	1 2	3 0	Yazoo City through lake	6	20
Birdie Bailey	109.7	111	22	3.5	1 10	4 0	....do	15	52

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	1,025	1,300	1,102	1,350	1,500
Cottonseed	3,250	2,650	1,805	2,505	2,100
Livestock	13	37	26	24	27
Lumber	3,021	3,530	1,270	1,46	1,230
Staves	800	710	.....	.....	3,615
Provisions	1,500	1,300	815	1,055	500
Grain	650	1,120	310	1,110	600
Miscellaneous	1,219	1,110	750	1,360	700
Total	12,078	11,757	6,078	8,864	10,272
Estimated value	$750,000	$684,000	$243,000	$537,000	$492,000

The Yazoo branch of the Illinois Central Railroad from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the lake, has a tap line from Tchula to the main line at Durant, and has diverted a large amount of business formerly done by steamboats.

U 13.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The head waters of Tallahatchee River are in Tippah County, in northern Mississippi, whence it flows in a general southwesterly direction through the counties of Union, Lafayette, and Panola, joins Coldwater River in Quitman, and then, as the main stream, flows in a southerly direction through Tallahatchee and Leflore counties, and unites with the Yallabusha in forming Yazoo River.

Under river and harbor act of June 18, 1878, an examination was made that year, and the project based thereon contemplated improvement of low-water navigation of the river from its junction with the Coldwater to the mouth, a distance of about 100 miles, by removal of snags, sunken logs, and leaning timber, and the wreck of the steamer *Star of the West*, 8 miles above the mouth. The estimated cost of the work was $40,000, if completed in two consecutive low-water seasons. (Report Chief of Engineers, 1879, pp. 982–986.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$6,000	August 11, 1888	$5,000
June 14, 1880	9,000	September 19, 1890	5,000
March 3, 1881	3,000	July 13, 1892	5,000
August 2, 1882	3,000	August 17, 1894	4,000
July 5, 1884	3,000		
August 5, 1886	3,500	Total	46,500

By the terms of the acts $5,000 of the appropriation of 1880, $2,000 of the appropriation of 1881, and all of the appropriation of 1882 were required to be expended above the mouth of Coldwater to Batesville, in the part known as the Little Tallahatchee, which was not included in the original project or estimate of cost.

The improvement was commenced at the mouth September 18, 1879, by the U. S. snag boat *Florence*, carried upstream to within 20 miles of Sharkey Landing, and suspended November 20, 1879. Operations during this period consisted of the removal of leaning timber, which obstructed navigation at all stages. Work with the *Florence* was resumed the latter part of August, 1880, at Pecan Point, continued

down to the mouth, and suspended October 18, 1880. For the stretch of river above mouth of Coldwater to Batesville a flatboat was built and fitted up with necessary machinery, and work commenced early in October, 1880, at the mouth of Coldwater, continued upstream to Batesville, and was suspended at the close of January, 1881. Operations consisted of removing snags, logs, leaning timber, rafts, and drift piles. This work was resumed at Batesville June 4, 1881, and between that date and August 9, 1881, was carried down to mouth of Coldwater. During this period the river was very low and in places blocked with drift, through which a channel was cut wide enough for boats to pass at a good stage of water. From the mouth of Coldwater the boat dropped downstream, removing the principal obstructions, as far as practicable with the limited amount available, on the way, and thoroughly clearing a bad stretch of river near Pecan Point, complained of by steamboat men, after which work was suspended about the middle of September, 1881. Under the act of 1882 work was resumed at Batesville September 15, carried down to within 6 miles of the mouth of Coldwater, and suspended November 30, 1882. Owing to lack of funds nothing was done the following season, but from November 1 to December 6, 1884, the U. S. snag boat *Meigs* was employed in thoroughly clearing the obstructions in the lower part of the river for a distance of about 25 miles above the mouth. Work with the *Meigs* was resumed under the next appropriation December 1, 1886, but December 27 the boat was withdrawn on account of high water until May 11, 1887, after which work was continued until June 10, 1887, and carried from the mouth to Sharkey Landing before the funds were exhausted. No work was done the following year, no funds being available; but May 18–31 and June 13–17, 1889, the *Meigs* again worked over the lower river as high as Williams's wood yard, 18 miles below Sharkey, suspending operations the latter date on account of high water. November 8 to December 24, 1889, the *Meigs* was employed between the mouth and Cassity Bayou, one-half mile below Sharkey. Under the act of 1890 the *Meigs* entered this river November 1, 1890, and worked rapidly up to Sharkey Landing, as it was desired to carry operations to the mouth of Coldwater before the water should fall. The boat reached a point 6 miles above Sharkey November 7, but found the water too low to go farther, and turned back, and was employed on the 40 miles below Sharkey until November 17. On the latter date a slight rise set in and the work was carried up to Mead Landing, at the mouth of Tillatoba River, about 25 miles above Sharkey, until November 25, 1890. During the remainder of November the boat worked in the lower part of the river. Nothing further was done until June 15, 1891, when the *Meigs*, which had been working in the Yazoo, entered this stream and worked for six days, removing tree slides, etc. During the month of October, 1891, the snag boat *Meigs* was employed in the lower 50 miles of the river until the funds available were exhausted. Under the act of 1892 the *Meigs* worked over the river below Sharkey, and thence upstream to the mouth of Coldwater, having been employed September 5–30, 1892, and April 6–26, 1893. September 14–26, 1893, the *Meigs* again worked over the lower river to the mouth of Cassity Bayou, one-half mile below Sharkey Landing, removing obstructions, chiefly tree slides, of which there was a large number.

The total amount expended to June 30, 1894, was $42,490.45, of which the laws required $10,000 to be expended above mouth of Coldwater. The work resulted in great benefit to navigation between the mouth and Sharkey Landing, about 65 miles above, enabling steamboats to run to

that place at all stages the year round. Before the improvement commenced there was navigation only about six months of the year. The appropriations were too small to permit much work above Sharkey, and until 1890 there was no demand for improvement of that part of the river, the steamboat interest stating that boats would not run above that landing, except to make occasional trips into Coldwater River at high stages when navigation was as good and about as safe as in the lower river.

The work in Little Tallahatchee River, above mouth of Coldwater to Batesville, resulted in no benefit to navigation or commerce, as there has been little or no trade in that part of the stream since the war.

Operations were not resumed during the fiscal year ending June 30, 1895, but the funds available will be expended for snagging operations during the season of low water this fall.

New obstructions are brought into the river every year by sliding and caving banks, and the shifting and scouring of the channel exposes snags and logs imbedded in the bottom or lodges them upon bars. An appropriation large enough to permit the systematic clearing of the banks, in addition to the usual snagging operations, can be expended profitably in one season of low water and result in permanent benefit to navigation.

Money statement.

July 1, 1894, balance unexpended	$9.55
Amount appropriated by act of August 17, 1894	4,000.00
	4,009.55
June 30, 1895, amount expended during fiscal year	365.65
July 1, 1895, balance unexpended	3,643.90
July 1, 1895, outstanding liabilities	6.50
July 1, 1895, balance available	3,637.40
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

The river was reported navigable to Sharkey the whole year.

List of stern-wheel steamboats navigating Tallahatchee River in fiscal year 1895.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
E. A. Pharr	63.61	90	29.9	4.2	1 10	3 6	Greenwood and points on Tallahatchee River.	34	37
H. M. Townsend (towboat).	87.7	116.7	18.	3.1	.....	.....	Pecan Point and Greenwood, towing stave barges.	.....	.....
Blanks Cornwall	232.4	140	29.	4.6	2 2	5 2	Vicksburg and Sharkey	26	230
John F. Allen	133.9	130.2	24.	4.2	1 8	4 0	.... do	70	197
Fifteen	75	103	18.	3.5	1 8	3 0	Greenwood and Sharkey	72	130
Ferd R.	45.5	93	16	3	1 6	2 6	Irregular trips, Greenwood and points on Tallahatchee River.	.....	.....

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	3,033	4,338	3,141	5,588	4,000
Cotton seed	6,940	7,300	4,400	8,257	6,000
Hides and skins	2	3	3	53	5
Live stock	46	30	30	31	32
Lumber	1,614	1,400	1,300	1,188	1,424
Staves	23,404	14,346	3,447	3,204	9,245
Provisions	4,800	4,700	3,450	5,571	4,200
Grain	6,300	6,100	1,800	5,725	4,800
Saw logs	20,000	49,500	26,700	24,473	19,000
Miscellaneous	4,800	5,100	4,100	6,329	5,000
Total	70,939	92,817	48,371	60,419	53,706
Estimated value	$2,061,000	$2,372,000	$908,000	$2,428,000	$2,115,000

The Yazoo and Mississippi Valley Railroad, operated by the Illinois Central Company, has a branch line from Clarksdale to Minter City, on the Tallahatchee, which is paralleled by a branch of the Southern Railway from Webbs to Itta Bena, and the Southern Railway and Illinois Central at Greenwood are competitors for the trade of Tallahatchee River.

U 14.

IMPROVEMENT OF STEELE AND WASHINGTON BAYOUS, MISSISSIPPI.

Steele Bayou has its source in Swan Lake, in Washington County, Miss., flows in a general southerly direction, forming the outlet of Lake Washington, with which it is connected by Washington Bayou, a stream about 7 miles in length, and enters Yazoo River about 12 miles above its mouth. Its course is parallel to the Mississippi and its length about 85 miles. The fall is slight and the stream is not navigable except when the Mississippi is high enough to fill the lower portion with backwater.

An examination of Steele Bayou from its mouth to Swan Lake was made under river and harbor act of August 2, 1882, and in January, 1883, the officer in charge reported adversely to the improvement. (Report Chief of Engineers, 1884, pp. 1360–1362.)

The following appropriations have been made, viz:

By act of—	
July 5, 1884	$2,500
August 5, 1886	2,500
August 11, 1888	2,500
September 19, 1890	2,500
July 13, 1892	2,500
Total	12,500

The act of 1884 provided for improving Steele Bayou alone; Washington Bayou has been included in subsequent appropriations. The project contemplates removing snags, stumps, drift, and leaning timber to improve high-water navigation.

Work with a chopping party was commenced at the foot of Swan Lake November 1, 1884, was carried down to the mouth of the bayou and suspended February 11, 1885, and consisted of the removal of the principal obstructions only. It was resumed November 1, 1886, at the head of Washington Bayou, continued down Steele Bayou about 40 miles, and suspended early in January, 1887, by high water. Nothing was done the following season, as the unexpended balance was not sufficient to resume work. February 11, 1889, a steamboat was hired

and employed for sixteen days in removing obstructions below the mouth of Washington Bayou down to within 8 miles of the mouth, and was then withdrawn on account of high water. July 12–17, 1889, a light-draft steamboat was employed to remove obstructions from Bon Eagle Plantation down to the mouth, about 22 miles. Under the act of 1890, the U. S. snag boat *Florence* was sent into Steele Bayou February 8, 1891, and worked until the end of that month, when it was withdrawn on account of high water. Operations extended from the mouth up to the foot of Poindexter Island, about 50 miles. From December 21, 1891, to February 12, 1892, a chopping party carried work from the mouth upstream about 22 miles before the available balance was exhausted.

From 1884 to the end of the fiscal year 1894 Steele Bayou was worked over twice from Swan Lake to the mouth, and the obstructions in Washington Bayou were removed in 1886, resulting in greater ease and safety to steamboat navigation at high stages, but operations were by no means thorough, on account of the small appropriations.

No work was done during the fiscal year ending June 30, 1895.

As soon as practicable the work of removing obstructions to high-water navigation will be resumed, and will continue until the funds available are expended.

The following extract from my report of 1894 remains applicable to this work:

The region bordering the upper part of Steele Bayou and Washington and Swan lakes furnishes the principal products. The lower part of the bayou is subject to overflow from backwater, and not much land in the vicinity is cultivated. The west side of Lake Washington is near the Mississippi, and a loop line of the Yazoo and Mississippi Valley Railroad, from Coahoma to Rolling Fork, passes between Swan Lake and Lake Washington and diverts the main traffic from the bayou before navigation opens.

Steamboat navigation in Steele Bayou was not commenced until 1879, and since the construction of the railroad in 1884 it has decreased steadily until for several years past the trade has amounted to little or nothing. In view of the limited commerce to be benefited and the cost of maintaining the work by the removal of new obstructions added from time to time it is not believed that any further amount can be expended profitably for the improvement of this stream, and estimates for that purpose are omitted.

Money statement.

July 1, 1894, balance unexpended	$2,443.26
July 1, 1895, balance unexpended	2,443.26

COMMERCIAL STATISTICS.

No boats ran in Steele Bayou during the fiscal year 1895, and no information could be obtained of any saw logs rafted out of the stream.

U 15.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

Big Sunflower has its source in Mud Lake, Coahoma County, Miss., 2½ miles from Friar Point, on the Mississippi, flows in a general southerly direction, and enters Yazoo River about 45 miles above its mouth. During extreme high water it is navigable to Clarksdale, about 280 miles above the mouth; but Faisonia, about 144 miles above the mouth, ordinarily is considered the head of navigation.

Under river and harbor act of June 18, 1878, an examination of this river was made, and the project based thereon contemplated the

removal of snags, sunken logs, and leaning timber obstructing navigation, and building wing dams to scour a channel from 3 feet to 40 inches deep through Oliphant Bar and Muscle Shoals, at an estimated cost of $66,000. Oliphant Bar begins at the mouth of the river and extends upstream 15 miles. Muscle Shoals begin about 38 miles above the mouth and extend upstream about 5 miles. (Report Chief of Engineers, 1879, pp. 982–984.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$20,000	August 11, 1888	$5,000
June 14, 1880	8,000	September 19, 1890	5,000
March 3, 1881	4,000	July 13, 1892	5,000
August 2, 1882	5,000	August 17, 1894	5,000
July 5, 1884	5,000		
August 5, 1886	5,000	Total	67,000

The amount expended to June 30, 1894, was $61,343.63. Work commenced in the fall of 1879 and continued at intervals when funds were available until March 25, 1893, when operations were suspended last, a résumé being given in my last report. (Pp. 1513, 1514, Report Chief of Engineers, 1894.) This work extended over the navigable part of the river, from Clarksdale to its mouth, though little was done above Faisonia since 1882, as the appropriations were too small to work over the whole stretch, and it would have resulted in no benefit to navigation to improve the upper river and allow the lower part to remain obstructed.

Before the improvement commenced navigation was badly obstructed by snags, sunken logs, leaning timber, and sand bars. Captain Benyaurd reported in 1879: "In many places the low-water channel, being filled with logs, is of no greater depth than 18 inches, while the confining snags on either side greatly reduce the width, leaving barely sufficient room for the safe passage of the small steamers that navigate the river. These obstructions are so general throughout the entire length of the stream, and are so constantly being brought in by the sliding banks, etc., that it would be useless to attempt any description of the points at which they are to be found. At all stages the leaning trees along the banks are serious obstructions to navigation." (Report Chief of Engineers, 1879, p. 983.) In 1879 the lower river was navigable for very light steamers about six months of the year, and it was unusual for a boat to make the round trip from Vicksburg under eight days. In 1890 it was navigable the year round, but difficult and dangerous at low stages on account of shoals, snags, and sunken logs. Larger boats were used and made the round trip in little more than half the time formerly required. Insurance rates were stated to be considerably less and freight rates were reported to have been reduced 50 per cent. The lands along the river were being cleared and settled rapidly, which was attributed partly to improved navigation. The appropriations since have been scarcely sufficient to maintain what had been accomplished in the preceding eleven years, and attention is invited to the following extract from my report of 1891, repeated each year since, viz:

> The estimate of $66,000, made in 1879, for the improvement of this river (p. 984, Report Chief of Engineers, 1879) did not contemplate doing the work at irregular intervals extending over a period of fifteen years, as it will with the usual appropriations, but was made with a view to finishing it in not more than three or four consecutive seasons. As new obstructions are added from time to time it is impossible to make any definite estimate, but if an appropriation of not less than $20,000 is made it can be spent to advantage and with economy in one or two low-water seasons and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

Work for the removal of obstructions to navigation was not resumed during the fiscal year ending June 30, 1895. A boat of very light draft with appliances for removing snags and logs in the channel is needed, but none was available from the district plant and the appropriation is too small for construction or hire of such a vessel. As soon as means can be devised for expenditure of the available funds with economy and profit to the work operations will be resumed. Probably the *Columbia*, the lightest snag boat of the district, recently overhauled and repaired, may be used to advantage for the purpose.

Under authority of the Chief of Engineers dated August 21, 1894, a line of precise levels was run by Assistant Engineer T. C. Thomas in September and October, 1894, from Friar Point, on the Mississippi, to Clarksdale as a base for checking levels to be run in surveying Big Sunflower River "with a view to its improvement as high as Clarksdale by locks and dams," directed by act of August 17, 1894. The levels cost $347.34, and $342.34 have been applied during the year to the care of the snag boat *Meigs*, which has been used to a considerable extent upon this work.

Money statement.

July 1, 1894, balance unexpended	$656.37
Amount appropriated by act of August 17, 1894	5,000.00
	5,656.37
June 30, 1895, amount expended during fiscal year	689.68
July 1, 1895, balance unexpended	4,966.69
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	20,000.00

COMMERCIAL STATISTICS.

The river was reported navigable during the fiscal year as follows: November–June, to Campbellsville; January–May, to Faisonia.

List of stern-wheel steamboats that navigated Big Sunflower River in fiscal year 189 5.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
John F. Allen	133.90	130.2	24	4.2	1 8	4 0	Vicksburg and Lehrton	12	87
Des Arc	40.88	95	18	3	1 4	3 0	Yazoo City and Lehrton	17	121
Birdie Bailey	109.74	111	22	3.5	1 10	4 0	Yazoo City and Campbellsville	40	211
Hibernia	157.06	135	25	4	2 6	4 0	Vicksburg and Woodburn	25	131
Fifteen	75.00	103	18	3.5	1 8	3 0	do	12	90
John L. Lowry	54.15	108	16	3.6	1 8	2 4	Vicksburg and Lehrton	4	
Novelty	49.45	76.4	16.4	3	1 3	3 6	do	18	132
							Vicksburg and the Nation	4	
							Vicksburg and Birch Place	1	
							Vicksburg and Lehrton	1	
							Vicksburg and Standing Stump.	1	
Crown Point	159.14	123	25	4.2	1 8	5 0	Vicksburg and Quiver River	1	
							Vicksburg and Vicks Landing	4	
							Vicksburg and Woodburn	2	
							Vicksburg and Campbellsville	2	
							Vicksburg and Riverside	2	
Yazonia	62.84	.....	.....	.....	1 6	3 6	Yazoo City and Holly Bluff	103	977
Maggie	.....	.....	.....	.....	1 5	3 6	do	75	489
							Vicksburg and Holly Bluff	4	
							Vicksburg and Woodburn	4	
Mima	62.72	66	17	3.2	1 2	2 6	Vicksburg and Lehrton	4	

Summary of commerce reported.

Articles.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	3,601	2,400	2,699	4,118	2,375	2,594	4,000
Cotton seed	5,760	5,700	5,250	5,450	3,500	3,975	6,000
Hides	24	12	19	12	.....	.....	1
Live stock	71	38	250	265	70	150	150
Saw logs	2,475	5,650	19,000	21,835	15,400	4,000	.....
Lumber	1,500	780	1,130	906	920	869	.....
Staves	8,105	9,405	9,840	4,430	3,219	5,250	490
Miscellaneous	375	2,050	1,088	2,549	2,027	.....	3,880
Total down freight	21,911	26,035	39,276	39,565	27,511	16,838	14,521
Return freight	2,623	4,285	4,023	7,489	4,473	5,322	9,680
Total	24,534	30,320	43,299	47,054	31,984	22,160	24,201
Estimated value	$956,000	$988,000	$893,000	$1,354,000	$945,000	$1,240,000	$1,858,000

The Yazoo and Mississippi Valley Railroad crosses the river at Clarksdale and thence runs south parallel to the stream at distances varying from 5 to 20 miles. The Georgia Pacific (Sixth) Division of the Southern Railroad crosses the river at Baird with a line running from Arkansas City, on the Mississippi River, to Atlanta, Ga.

U 16.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

Big Hatchee River has its source in northern Mississippi, flows in a northwesterly and then westerly direction through the most productive region of west Tennessee, and enters Mississippi River 50 miles above Memphis. Navigation of this stream was commenced as early as 1827. In 1841 and 1842 the State of Tennessee appropriated $100,000 for improvement of rivers in the western part of the State, one-third of which was expended on Big Hatchee, after which considerable commerce developed, six or seven steamboats having been employed during the cotton season, and it is stated that there was navigation for light-draft boats the year round. In 1866 the legislature of Tennessee declared the stream unnavigable and authorized the construction of fixed railway bridges across it, in consequence of which navigation was suspended until 1879, when the act was repealed and the railroad companies changed their bridges to conform to the law.

Under section 2 of river and harbor act of August 14, 1876, which provided for "examination and survey of such rivers and harbors as in the judgment of the Secretary of War will subserve the general interests of commerce," an examination of this river was ordered; but, in view of the State law declaring the river unnavigable, it was deferred until after repeal of the act in 1879. The project, based upon this examination, contemplated the removal of snags, logs, leaning timber, etc., to render the stream navigable for light-draft boats throughout the year from Bolivar, Tenn., to the mouth, a distance estimated to be about 240 miles. The plan contemplated completing work in three consecutive seasons of low water, at a cost of $30,000. (Report Chief of Engineers, 1880, pp. 1330–1332.)

The appropriations are as follows:

By act of—		By act of—	
June 14, 1880	$10,000	August 11, 1888	$5,000
March 3, 1881	3,500	September 19, 1890	5,000
August 2, 1882	3,000	July 13, 1892	3,500
July 5, 1884	2,500		
August 5, 1886	3,000	Total	35,500

Operations from the commencement of the improvement by the United States to the close of the fiscal year 1894 were as follows:

A chopping party commenced work at Bolivar August 13, 1880, and continued downstream to the mouth of the river, which was reached December 10, 1880. This work consisted chiefly of clearing the leaning timber, but snags and logs were removed from the channel wherever practicable with the means at hand. In 1881 a chopping party resumed work at Bolivar June 22, and between that date and October 15 carried it down to the mouth, giving special attention to the removal of obstructions in the channel. August 28 to November 4, 1882, the work was gone over again from Bolivar to Reed Landing, 27½ miles above the mouth, many new obstructions having been added during the year by caving banks, etc. Owing to lack of funds nothing further was done until December 14, 1884, when a chopping party commenced work at Piljerk Landing, 40 miles above the mouth, and continued upstream about 40 miles, thoroughly removing all obstructions to navigation until February 10, 1885, when operations were suspended by high water. Nothing was done the following low-water season, as the balance available was insufficient to resume operations. October 15, 1886, work was begun at the mouth and continued until January 15, 1887, when it was stopped by high water, having been carried up to Rialto, about 60 miles. The small balance was expended June 17–27, 1887, in working from Rialto back to the mouth, giving a fair navigable channel in that stretch of river. The next work, April 5 to June 14, 1889, was carried from Rialto upstream to the Louisville and Nashville Railroad bridge, a distance of about 60 miles, and August 19 to October 31, 1889, a hand-propelled snag boat was employed in removing obstructions from the bottom of the river below Rialto, clearing a good channel between that place and the mouth, with a depth of 2½ feet at low stages. The next work was done by the U. S. snag boat *Florence*, January 1 to March 5, 1892, between the mouth and Green Landing, about 67 miles above, and was suspended by high water. Work was not resumed until June, 1894. In that month operations of a chopping party commenced at Rialto, were carried upstream above Green Landing, 14¼ miles, and still were in progress at the close of the year.

When the improvement commenced in 1880 the river was unnavigable on account of obstructions in the channel and leaning timber. In 1889 it was reported navigable for seven months, in 1891 for nine months, in 1893 for eight months, and in 1894 for seven months. Between Bolivar and the mouth it is crossed by four railroads, about 60 miles apart, which transport the products of the adjacent country, and the main effect of the work done has been to facilitate transportation of timber rafts and staves loaded on barges. Steamboats have not navigated the river for years, except small tugs and towboats, sent up short distances during high stages to bring out saw logs and stave boats.

During the fiscal year ending June 30, 1895, operations were continued as follows:

July 2, 1894, the chopping party above Green Landing moved back to Rialto, and worked thence downstream, and, after suspension of operations in Forked Deer River, the party that had been employed in that stream moved down to mouth of Big Hatchee and commenced working upstream July 11. The two parties met at Price Bluff, about 20 miles above the mouth, August 6. The available funds being exhausted, on August 7–8 the barges were dropped downstream to the Mississippi, and thence to Memphis, where they were returned to Captain Roessler, from whom borrowed in May, 1894.

The work was carried on under the supervision of Overseer Watkins Decker, and consisted of removing obstructions in the channel by means of capstans and explosives, cutting and blowing up shore snags, stumps, and logs along the banks, and felling and girdling leaning timber. The water was at a low stage, favorable for effective work, but the stream was so filled with caved-in trees that it was impracticable with the means available to remove any but the most dangerous obstructions. This rendered navigation easy and comparatively safe at medium and high stages, but if effort had been made to remove all obstructions a very short stretch could have been worked over, and no benefit would have been derived.

The following is a summary of the work done, viz:

Channel snags removed	3,607
Stumps removed	1,241
Shore snags removed	2,169
Logs removed	2,427
Jams removed	4
Side jams removed	6
Trees removed from channel	175
Leaning trees removed	5,483
Leaning trees topped	3
Trees girdled	10,808
Square yards willows and brush cut	8,867

Wrecks removed, viz: Stave boat, just below Chesapeake, Ohio and Southwestern Railroad Bridge.

Overseer Decker reported that if the snags and logs were removed from the channel the stream would afford navigation the year round for boats drawing 3 to 4 feet, but that it is so much obstructed at present and the banks are caving so badly that the work would cost from $75,000 to $100,000, with little probability that boats could be induced to run after it was completed.

I can find no reason for changing the recommendation made in previous reports, viz:

The small amount of commerce to be benefited is not at all commensurate to the cost of continuing this improvement, or to maintaining what has been done, and for this reason it is not believed that an additional appropriation can be expended profitably unless a greatly increased business be developed.

Money statement.

July 1, 1894, balance unexpended	$3,255.28
June 30, 1895, amount expended during fiscal year	3,255.28

COMMERCIAL STATISTICS.

The river was reported navigable during fiscal year from February 1 to the middle of May.

List of stern-wheel steamboats engaged in navigating Big Hatchee River in fiscal year 1895.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Maggie Belle	52.81	95.6	18.4	3.6	2 6	.....	Mouth and Rialto	7	....
Golden Gate	142.17	131.4	30	4	2 0	4 0	Memphis and Morgan Landing	2	14
Ed Durant, jr	153.49	113.6	29.6	4.6	1 8	3 6	.....do	2	....
Uncle Billy	79.81	88	17.7	3.9	1 8	4 0	125 miles up river	2	....
Joy Patton	63.04	100	21.3	5.6	3 6	4 0	Towing logs out of Indian Creek.	....	....
Welcome (tug)	11.33	64.8	16.3	5.6	6 0	6 0	.....do	....	....
White Oak (tug)	31.32	69	13	6.4	5 6	8 6	Mouth and Green Landing	2	....

Summary of commerce reported.

Articles.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	6				23
Lumber (saw logs)	3,000	18,920		4,450	6,010
Staves and heading	3,810	4 920	5,079	500	11,600
Miscellaneous	213				25
Total	7,029	23,840	5,079	4,950	17,658
Estimated value	$46,000	$98,000	$34,500	$30,000	$184,500

The Illinois Central Railroad (Mississippi and Louisiana divisions) crosses the river at Bolivar, the head of proposed improvement. The Paducah, Tennessee and Alabama Railroad (Tennessee Midland) crosses at Hatchee Station, about 178 miles above the mouth; the Louisville and Nashville Railroad crosses at Big Hatchee Station, about 117 miles above the mouth; and the Chesapeake, Ohio and Southwestern Railroad crosses at Rialto, about 57 miles above the mouth.

U 17.

WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were designed to secure information from continuous records with a view to protection of the alluvial lands against overflow, the improvement of navigation, and to give correct reports of the stages of water for the benefit of river men and planters. They were ordered by joint resolution of Congress, approved February 21, 1871 (sec. 5252, Rev. Stat.), viz:

SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas, and Alexandria, on the Red River, and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of five thousand dollars.

Soon after the gauges were established and observations commenced it became evident that the sum of $5,000 annually was not sufficient to cover the expenses of repairs and frequent inspections essential to accuracy, and during the years in which no appropriations were made for improvement of rivers and harbors various expedients had to be resorted to to maintain the service. In 1878 observations were stopped for want of funds, but many observers continued the records without compensation; in 1884 a deficiency appropriation was made for their continuance; in 1886 the Mississippi River Commission paid the observers and repaired and inspected the gauges on the Mississippi to prevent suspensions, and in 1887–88 the readings were continued voluntarily by the observers. At this rate it was easily seen that the work would have to cease unless new legislation should be enacted for maintaining the gauges, and the river and harbor act of August 11, 1888, provided a permanent indefinite appropriation for the purpose, as follows:

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the

application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however*, That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The amount appropriated in the act of August 11, 1888, was—

For gauging the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of twenty-first of February, eighteen hundred and seventy-one, nine thousand six hundred dollars: *Provided*, That three thousand six hundred dollars of same is authorized to be expended in paying the expenses of gauging the said waters during the fiscal year ending June thirtieth, eighteen hundred and eighty-eight.

The same act, in the item of appropriation for continuing operations upon the reservoirs at the headwaters of the Mississippi River, provided as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

Although the act provides an annual appropriation of not to exceed $9,600, and although that amount was allotted for the fiscal years 1889, 1890, and 1891, a ruling was made in April, 1891, that only $6,000 could be drawn from the Treasury during each fiscal year. In consequence of that ruling observations at the greater number of the gauges for the last quarter of the fiscal year 1891 were paid for from the appropriations for works benefited by maintaining the records, as the funds in hand were exhausted, $900 having been allotted for gauging at or near St. Paul.

The appropriations and allotments for this work have been as follows:

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000
June 10, 1872	5,000
March 3, 1873	5,000
June 23, 1874	5,000
March 3, 1875	5,000
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000
June 18, 1878	5,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	5,000
Deficiency act of March 12, 1884	2,100
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000
August 5, 1886	5,000
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700
Deficiency act of October 19, 1888	3,600
Allotments from permanent appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000
1891	8,700
1892	5,100
1893	5,500
1894	5,500
1895	5,500
Total	118,700

Prior to 1892 it was held that the unexpended balance of an allotment at the close of a fiscal year could not be used in addition to the allotment for a succeeding year, but July 13, 1892, the Secretary of the

Treasury decided that the allotments made under section 6 of the act of August 11, 1888, were "no limit" appropriations.

The following statement shows the disposition of the funds apportioned to this work:

Amount expended to June 30, 1895	$108,733.69
Amount of deficiency appropriation of October 19, 1888, not used	3,600.00
Balance of appropriation by act of August 11, 1888, not expended	1,566.29
Balance of allotment for fiscal year 1890, not expended	1,281.66
Portion of allotment for fiscal year 1891, withheld at U. S. Treasury under ruling that only $6,000 can be drawn each fiscal year	3,518.34
Balance unexpended July 1, 1895	.02
Total, as above	118,700.00

The gauges ordered by the resolution of February 21, 1871, were established the latter part of that year, except that at Carrollton, La., established in January, 1872. A gauge was placed at the mouth of White River instead of at Napoleon, Ark., as the latter place was caving into the river. Two gauges were established at Louisville, Ky., one at head and one at foot of the falls, and at the request of the steamboat interest, a gauge was set up at Natchez, Miss. In August, 1873, a gauge was established at Nashville, Tenn., on Cumberland River. In February, 1890, additional gauges were established on Red River at Shreveport, La., and Garland and Fulton, Ark., and one at Donaldsonville, La., on the Mississippi, was established in June, 1890.

The gauge at Rock Island, Ill., was discontinued April 30, 1879, because observations so far upstream were no longer needed, and the gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, but readings at the latter place have been continued by the Missouri River Commission.

Observations commenced at each station as soon as the gauge was set up, and with a few exceptions, during the periods when no funds were available, have been continued regularly since. In 1881 bulletins were erected at stations on the Mississippi for the purpose of giving passing steamboats the stage of water at each reading, and showing whether the river was rising, stationary, or falling. The size of the plates in the original bulletins was 20¾ by 24 inches, black figures on white ground, but in 1890 they were replaced by larger bulletins, one-sixteenth inch sheet-iron plates, each 40 by 48 inches, white figures on black ground, which are large enough to be read easily with the naked eye at a distance of half a mile. The old bulletins were repaired and used in extending the service to the tributaries. From 1871 to February 1, 1887, the gauges were read and bulletins changed at 8 a. m. daily, but since the latter date this has been done at 8 a. m. and 4 p. m. every day, and greater uniformity and accuracy have been secured by the change. The gauge readings are received at this office weekly and are reviewed, consolidated, and sent to the Secretary of the Mississippi River Commission, by whom they have been published to the end of the calendar year 1894.

Gauge staves are made in advance at Vicksburg and shipped when needed, a few sections being kept on hand at stations with caving banks or where the gauge must be set in an exposed place. They are of two sizes, the larger to be bolted to bridges, wharves, etc., and the smaller, for temporary service, to be driven into the bank at successive stages, rising or falling. Numbers and graduations in feet and tenths are branded, thus saving time and money, giving uniform scales, and marks not easily obliterated.

The Engineer gauges are used by the Weather Bureau at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., Vicksburg, Miss.,

Donaldsonville, La., Florence, Ala., Nashville, Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark.

The present service consists of twenty-two gauges, located as follows, and at which observations were continued during the fiscal year ending June 30, 1895, viz: On Mississippi River at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of White River, Ark., Lake Providence, La., Vicksburg, Miss., Natchez, Miss., Red River Landing, La., Baton Rouge, La., Donaldsonville, La., and Carrollton (New Orleans), La.; on Ohio River at Louisville, Ky., head of falls and foot of falls; on Tennessee River at Florence, Ala.; on Cumberland River at Nashville, Tenn.; on White River at Jacksonport, Ark.; on Arkansas River at Little Rock, Ark.; and on Red River at Alexandria and Shreveport, La., and Garland and Fulton, Ark.

Records of the daily readings were furnished the president of the Mississippi River Commission; copy of the Florence record was furnished the engineer officer in charge of Lower Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi; copy of the Jacksonport record was sent the chief engineer of the Board of Mississippi Levee Commissioners; and district officers, levee commissioners, etc., were furnished copies of records at various stations upon application.

The following gauges were inspected during the year by Assistant Engineer John Ewens, viz:

September.—(10th) Vicksburg, Miss., entire gauge rebuilt; (18th) Natchez, Miss., gauge rebuilt from —1 to 50 foot mark; (24th) Red River Landing, La., gauge rebuilt from 0 to 50 foot mark; (27th) Baton Rouge, La., gauge rebuilt from 0 to 26 foot mark; (29th) Donaldsonville, La., gauge reset from 0 to 14.5 foot mark.

October.—(2d) Carrollton, La., gauge rebuilt from —2 to 19 foot mark; (10th) Lake Providence, La., gauge rebuilt from —3 to 44 foot mark; (12th) Helena, Ark., gauge rebuilt from —1 to 15.6 and 45 to 52 foot marks; (16th) mouth of White River, Ark., gauge rebuilt from 0 to 52.2 foot mark; (19th) Memphis, Tenn., gauge rebuilt from —2 to 39 foot mark; (23d) Florence, Ala., gauge rebuilt from —2 to 21 foot mark; (25th) Nashville, Tenn., gauge rebuilt from —2 to 46 foot mark.

November.—(1st) Louisville, Ky., both gauges repainted and figured; (5th) Cairo, Ill., débris and deposit removed from gauge; (7th) St. Louis, Mo., gauge rebuilt from 3.1 to 41.5 foot mark; (13th) Jacksonport, Ark., gauge rebuilt from —2 to 36 foot mark; (16th) Little Rock, Ark., gauge rebuilt from —0.5 to 34 foot mark; (22d) Garland, Ark., gauge rebuilt from 0 to 32 foot mark; (24th) Fulton, Ark., gauge rebuilt from 0 to 35.5 foot mark; (26th) Shreveport, La., gauge rebuilt from —8.1 to 37 foot mark.

December.—(3d) Alexandria, La., gauge rebuilt from —5 to 39 foot mark; (7th) Vicksburg, Miss., gauge rebuilt from —7 to 18.5 foot mark; (10th) Natchez, Miss., gauge rebuilt from —1 to 51 foot mark.

January.—(24th) Vicksburg, Miss., gauge rebuilt from 22 to 32 foot mark.

Photographs* are sent herewith showing the inclined gauge at St. Louis, Mo., as rebuilt in November, new vertical high-water section of same, and the two sections of new vertical gauge on Baring Cross Bridge at Little Rock, Ark., constructed in November.

The following tables show the prevalence of extraordinary low stages at all the stations the entire year:

* Not printed.

Comparison of flood of 1895 with highest water recorded since establishment of present gauges.

Gauge stations.	Year gauge was established	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean gulf level at Biloxi, Miss.*	Highest water previously recorded on present gauge.		Highest water during fiscal year ending June 30, 1895.		Relation to previous highest record.
				Date.	Gauge reading.	Date.	Gauge reading.	Below.
		Feet.	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Louis, Mo	1871	400.23	378.97	May 19, 1892	35.95	July 1	17.22	18.73
Cairo, Ill	1871	290.84	269.58	Feb. 27, 1883	52.17	Jan. 21, 22	33	19.17
Memphis, Tenn	1871	203.97	182.71	Mar. 23, 24.. Apr. 4, 5, 1890	35.60	Jan. 23, 24	24.05	11.55
Helena, Ark	1871	161.98	140.72	Apr. 30, 1886	48.10	Mar. 30, 31	31.30	16.80
Mouth of White River, Ark.	1871	128.73	107.47	Mar. 31, 1890	50.40	Apr. 1	34.35	16.05
Lake Providence, La.	1871	89.62	68.36	June 2, 1892	41.90	Apr. 2, 3	25.90	16
Vicksburg, Miss	1871	66.04	44.78	Apr. 24, 25, 1890	49.05	Apr. 3, 4	31.70	17.35
Natchez, Miss	1871	36.89	15.63	Apr. 23, 1890	48.60	Apr. 3, 5	31.50	17.10
Red River Landing, La.	1871	23.85	2.59	June 27, 1892	48.87	Apr. 4, 6	31.22	17.65
Baton Rouge, La	1871	20.06	—1.20	June 28, 1892	38.45	Apr. 6	23.65	14.80
Donaldsonville, La.	1890	†19.14	†—2.12	June 23, 1893	30.60	do	18.60	12
Carrollton, La	1872	20.91	—.35	June 22, 1893	17.45	Apr. 8	10.15	7.30
Louisville, Ky. (upper).	1871	†419.76	†398.50	Feb. 16, 1884	46.60	Jan. 15	20.70	25.90
Louisville, Ky. (lower).	1871	†392.85	†371.59	do	72	do	46.10	25.90
Florence, Ala	1871			Jan. 22, 1882	29.60	Jan. 17	17.50	12.10
Nashville, Tenn	1873			do	55.30	Mar. 25	31.70	23.60
Jacksonport, Ark.	1871			Mar. 14, 1890	33.35	July 7	21.95	11.40
Little Rock, Ark	1871	241.50	220.24	May 21, 1892	31.20	July 5	12.40	18.80
Alexandria, La	1871	64.46	43.20	June 12, 13, 1892	38.25	June, 25–27, and 30.	11.70	26.55
Shreveport, La	1890	161.27	140.01	May 28, 1892	35.70	June 30	12.10	23.60
Garland, Ark	1890	223.44	202.18	Mar. 24, 1894	28.50	June 23, 24	23.85	4.65
Fulton, Ark	1890	244.78	223.52	May 23, 24, 1892	34.85	June 22, 23	24	10.85

* Mississippi River Commission preliminary value, 21.26 feet above Cairo datum plane.
† Preliminary value.

Comparison of low water of 1895 with lowest previously recorded since establishment of present gauges.

Gauge stations.	Year gauge was established.	Lowest water previously recorded on present gauge.		Lowest water during fiscal year ending June 30, 1895.		Relation to previous lowest record.	
		Date.	Gauge reading.	Date.	Gauge reading.	Above.	Below.
			Feet.		*Feet.*	*Feet.*	*Feet.*
St. Louis, Mo	1871	Dec. 8, 9, 1893	.10	Jan. 13*	—.80		.90
Cairo, Ill	1871	Dec. 24, 1871	—1.00	Nov. 3	2.81	3.81	
Memphis, Tenn	1871	Dec. 25, 1872	—.95	Nov. 6–8	—1.40		.45
Helena, Ark	1871	Jan. 5, 1888	—.18	Nov. 8	—2.23		2.05
Mouth White River, Arkansas	1871	Dec. 28, 1872	0.00	Nov. 7, 8	2.65	2.65	
Lake Providence, La.	1871	Dec. 29, 1872	—3.85	Nov. 9, 11, 12	—4.25		.40
Vicksburg, Miss	1871	Nov. 24, 1887	—3.91	Nov. 11–14	—5.31		1.40
Natchez, Miss	1871	Dec. 14, 15, 1872	0.00	Nov. 10–13	1.	1.	
Red River Landing, La.	1871	Dec. 15, 1872	0.00	Nov. 12	—.25		.25
Baton Rouge, La	1871	Jan. 9, 1877	.90	Nov. 14	.45		.45
Donaldsonville, La.	1890	Nov. 6, 1891	1.70	Nov. 11	1.		.70
Carrollton, La	1872	Dec. 27, 1872	—1.60	Nov. 15	—.05	1.55	
Louisville, Ky., (upper).	1871	Sept. 10–14, 18–22, 1881.	1.70	Oct. 20	2.	.30	
Louisville, Ky., (lower).	1871	Oct. 17, 18, 1872	1.60	Sept. 7	2.60	1.	
Florence, Ala	1871	Sept. 18, 1878	—.76	Oct. 27, Oct. 30–Nov. 2	—.10	.66	
Nashville, Tenn	1873	Oct. 15, 16, 1878	—.40	Oct. 29–31	—.10	.30	
Jacksonport, Ark	1871	Dec. 24, 1872	—1.10	Nov. 30–Dec. 1	.70	1.80	
Little Rock, Ark	1871	Oct. 23, 24, 1879	—1.	Nov. 29–Dec. 2	3.20	4.20	
Alexandria, La	1871	Sep. 29, 1881	—3.70	Dec. 2, 3	—2.25	1.45	
Shreveport, La	1890	Oct. 1, 2, Nov. 20, 1893	—2.60	Dec. 2–4	—5.50		2.90
Garland, Ark	1890	Nov. 19, 20, 1893	1.69	Nov. 30–Dec. 2	1.10		.59
Fulton, Ark	1890	Nov. 20, 1893	3.35	Nov. 27–Dec. 7	2.85		.50

* Ice gorge in St. Louis Harbor above gauge.

Itemized statement of expenditures during the fiscal year ending June 30, 1895, submitted in compliance with requirements of section 6 of river and harbor act of 1888.

Observations:		
Pay of 21 permanent gauge keepers from July 1, 1894, to June 30, 1895, inclusive	$3,705.00	
Paid heirs of deceased gauge keeper, St. Louis, Mo., for services July 1–17, 1890	11.00	
Paid heirs of deceased gauge keeper, Garland, Ark., for services January 1–31, 1892	10.00	
		$3,726.00
Inspections and repairs:		
Pay of assistant engineer, six months, two and one-half days, at $150 per month	912.50	
Traveling expenses of assistant engineer while inspecting gauges	293.15	
Pay of employees hired to assist gauge inspector and to repair gauges and bulletins	56.00	
Material for repair of gauges	147.10	
Transportation of material for repair of gauges	16.60	
Repairs of Vicksburg, Miss., gauge and bulletin (piecework)	30.60	
Repairs of Shreveport, La., gauge (piecework)	21.00	
Rebuilding St. Louis, Mo., gauge (piecework)	55.49	
Rebuilding Little Rock, Ark., gauge (piecework)	15.00	
Regraduating Nashville, Tenn., iron gauge (piecework)	5.00	
Removing sediment and resetting Helena, Ark., gauge (piecework)	3.25	
One set of burning brands for marking gauges	20.00	
Transportation of brands to Vicksburg, Miss	1.10	
Furnace and charcoal for heating brands	3.30	
		1,580.09
Office expenses and contingencies:		
Pay of clerk, one month, at $90, twenty-one days, at $100	160.00	
Stationery	50.24	
Telegrams	.51	
Transportation of notebooks, etc., Mississippi Delta survey to office of the Chief of Engineers	5.60	
		216.35
Total		5,522.44

Money statement.

July 1, 1894, balance unexpended	$22.46
Amount allotted for fiscal year ending June 30, 1895	5,500.00
	5,522.46
June 30, 1895, amount expended during fiscal year	5,522.44
July 1, 1895, balance unexpended	.02
Amount allotted for fiscal year ending June 30, 1896	5,500.00
Amount available for fiscal year ending June 30, 1896	5,500.02
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	12,000.00

U 18.

PRELIMINARY EXAMINATION OF BAYOU DUGDEMONA, LOUISIANA.

[Printed in House Ex. Doc. No. 301, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 5, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 29, 1895, by Capt. J. H. Willard, Corps of Engineers, of the results of a preliminary examination of Bayou Dugdemona, Louisiana, made to comply with provisions of the river and harbor act of August 17, 1894.

It is the opinion of Captain Willard, concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office, that this bayou or river is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., January 29, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Bayou Dugdemona, Louisiana, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894:

Dugdemona River or Bayou, is a tortuous creek which has its source in Bienville Parish, flows in a general southeasterly direction across Winn Parish, and unites with Bayou Castor in forming Little River. Its course is through an uninhabited swamp about 2 miles wide, and the surrounding country is hilly, sparsely settled, and the soil is thin.

Under the requirements of section 6 of the river and harbor act approved August 5, 1886, an examination of this stream was made under my direction by Assistant Engineer Walter S. Davis in March, 1887. He rode south from Ruston, a town on the Vicksburg, Shreveport and Pacific Railroad, about 46 miles across the country drained by Dugdemona River to Winnfield, a small village, the seat of Winn Parish, situated about 2 miles from the stream. From Winnfield he descended the creek in a canoe to its confluence with Bayou Castor. He reported the channel was narrow, constantly changing in consequence of a sandy bed and swift current, with many abrupt bends, across which were numerous chutes, through which the water poured before the stream became half bank full. Some years prior, it was said, the owners of a small steamboat had been induced to make a trip nearly as high as Winnfield, but could find no place to turn round, and were compelled to back out the entire distance. In making the descent the boat barely escaped loss, its upper works having been carried away by leaning timber. The commerce was found to consist of rafting stave timber to a limited extent. The country around Winnfield is under

cultivation, and produces a certain amount of cotton, estimated in 1887 not to exceed 2,000 bales annually, which is hauled to Ouachita River or the railroads.

No argument in favor of improving the stream could be given then and none has developed since. The removal of leaning timber and snags might give a degree of safety to navigation by flatboats and rafts, but owing to the shifting channel and short bends the work would not be permanent, would have to be renewed from time to time for many years, and the cost would be out of proportion to any possible benefits to commerce that might arise. In view of the foregoing and the fact that Bayou Castor and Little River below to Catahoula Lake have nothing to recommend their improvement, I can find no reason for changing the opinion given in my report of 1887, that Dugdemona River is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION.
New York, February 2, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Captain Willard, I do not consider this stream worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

U 19.

PRELIMINARY EXAMINATION OF BAYOU CASTOR, LOUISIANA.

[Printed in House Ex. Doc. No. 303, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 5, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 29, 1895, by Capt. J. H. Willard, Corps of Engineers, of the results of a preliminary examination of Bayou Castor, Louisiana, made to comply with provisions of the river and harbor act of August 17, 1894.

Captain Willard is of opinion that this bayou is not worthy of improvement by the General Government, and his opinion is concurred in by Col. C. B. Comstock, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., January 29, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Bayou Castor, Louisiana, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894.

Bayou Castor, with its tributary creeks, drains a portion of the country south of the Vicksburg, Shreveport and Pacific Railroad and west of Ouachita River, flowing from 6 to 8 miles from the latter for a considerable distance above and below Columbia, La. Its general course is southerly to its junction with Dugdemona River in forming Little River, a stream that flows into Catahoula Lake, which is drained into Red and Ouachita rivers and sometimes filled by high water from the latter through another Little River at Trinity. Catahoula Lake is dry in summer and grass-grown. Bayou Castor is the same kind of a stream as Dugdemona River, which has been examined and reported as not worthy of improvement.

An examination of this stream was ordered by section 17 of river and harbor act approved September 19, 1890, and was made under my direction by Assistant Engineer R. S. Buck, jr., in October, 1890; the report upon which was published in the Report of the Chief of Engineers for 1891, pages 2028–2030, from which the following extract is taken:

After leaving the mouth I proceeded up the bayou as far as Castor Sulphur Springs, about 25 miles from the mouth. On account of the density of the swamps on both sides of the bayou and the numerous sloughs and tributary bayous, it was impossible to follow the bayou closely after the road left it, either in a vehicle or on horseback, and it would have been useless work of many days to attempt it on foot. Further, the bayou at that stage was so blocked up with logs and snags that even if a skiff or dugout had been procurable it would have been impossible to go up by that means.

However, I struck the bayou wherever it was practicable to do so, and saw enough of it and secured sufficient information from the natives to ascertain the value of the stream and the advisability of attempting improvement.

Bayou Castor, in conjunction with Dugdemona River, forms Little River, and, at the stage at which it was examined, furnishes not more than one-tenth as much water to that river as the other tributary. This is not so much on account of difference in cross section as in current velocity. The current in Bayou Castor near its mouth is about one-third mile per hour, while that of Dugdemona River is not less than 2 miles per hour.

Bayou Castor is of very uniform cross section, with steep banks, and throughout its entire length is a succession of bends more or less sharp. There are no marked irregularities or bar formations. As high as Castor Sulphur Springs it runs through dense swamps, and its banks are covered with underbrush and trees down to the water's edge. The channel is filled with snags, brush, cypress trees, and knees.

From parties well acquainted with the bayou I learned that the character of the stream, though greatly diminished in size, and the country through which it runs is much the same above Castor Sulphur Springs as below. From top to top of banks near the mouth the bayou is about 200 feet wide, and from water's edge to water's edge about 60 feet. In that vicinity soundings in the deepest part ranged from 3 to 5 feet. The water was 2 feet above lowest stage. There the banks are from 17 to 20 feet high, and the water in time of flood reaches 8 or 10 feet over the banks. The range of fluctuation is, therefore, about 30 feet.

At the Pendarvis place, 10 miles above the mouth, the banks are about 25 feet high; from top to top of banks the bayou is 175 feet wide; from water's edge to water's edge, 40 to 50 feet. Velocity of current in pools is about one-half mile per hour; on rapids, about 2 miles per hour. Stage about 2 feet above extreme low water. Depth from 2 to 3 feet. The bayou breaks up into a succession of pools and rapids about 7 miles above the mouth.

At the Pendarvis place the backwater reaches about 20 feet above low water, but freshet from above has reached as high as 40 feet above low water. This excessive flood height is doubtless due to great contraction of high-water section, caused by the hills coming in to the bayou.

At Castor Sulphur Springs the bayou is 140 feet from top to top of banks and 45 feet from water's edge to water's edge. The banks are about 15 feet high and the water 5 feet deep when 5 feet above extreme low water, at which stage the bayou is almost dry.

Backwater has never reached a higher point than 3 miles below Castor Sulphur Springs, but freshet water reaches 30 feet above low water. No examination was made above Castor Sulphur Springs, as the impracticability of making any improvement below develops into impossibility above. As stated, the bayou runs through a dense swamp, varying in width from one-quarter to 3 miles. In places the pine hills come up to the bayou bank.

Statistics as to the demands of commerce and the business done on this bayou are necessarily crude and uncertain. However, enough could be gathered for practical purposes, and I am liberal in allowances. From Castor Sulphur Springs to the mouth of the bayou there are four or five small plantations. The swamps bordering on the bayou are incapable of cultivation, the places being on the hills.

The highest point ever reached by a steamboat was 3 miles below Castor Sulphur Springs, or 22 miles above the mouth. The highest point reached by steamboat during the past twenty-three years (according to E. H. Pendarvis) was 8 miles above the mouth; however, flatboats for carrying out staves have gone higher. The bayou is navigable during four or five months in the year. One or two boats go up the bayou in a season.

The amount of business done yearly is about as follows:

Pine logs rafted, 20,000, at about 60 cents per log	$12,000
Staves carried out, 10,000, at about $125 per thousand	1,250
Cotton and merchandise, uncertain and inconsiderable, but about	2,000
Total	15,250

So the amount of business done on this bayou can not exceed, by liberal estimate, $16,000.

From Castor Sulphur Springs to the mouth of the Houston, Central Arkansas and Northern Railroad runs at a distance from the bayou in most places not exceeding 1 or 2 miles, and never exceeding 4 miles.

Except when high water is backed up from below no boat can get up the bayou. When the bayou is high from head water the fluctuation is too rapid and the current too strong to admit of navigation among the sharp bends, overhanging trees, and cross currents.

* * * Cutting bends and thereby straightening the stream is altogether impracticable and no remedy for existing difficulties. In fact, the character of the stream and the country through which it flows, in my opinion, renders any attempt at improvement inadvisable.

The conditions now practically are the same as when the examination was made four years ago, with the exception that the Houston, Central Arkansas and Northern division of the Missouri Pacific Railway system has been completed to the southern terminal at Alexandria, La. It connects with the St. Louis, Iron Mountain and Southern Railway at McGehee and Dermott, Ark., a few miles west of Arkansas City, on the Mississippi, touches Ouachita River at Monroe, La., crosses it near Columbia, and runs near and parallel to Bayou Castor, crosses Little River just below the confluence of Castor and Dugdemona, and at Alexandria has direct connections with New Orleans by two lines of railway and by Red River.

The chief function of bayous Dugdemona and Castor is to drain the neighboring country, and the only business done on them is rafting timber and floating out staves in flatboats. Little River, below their junction to Catahoula Lake, has not been deemed worthy of improvement. * * *

In view of these facts I can find no reason for changing the opinion given in my former report, that Bayou Castor is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, February 2, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Captain Willard I do not consider this stream worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

U 20.

PRELIMINARY EXAMINATION OF LITTLE RIVER, ARKANSAS, FROM FULTON TO WHITE CLIFFS.

[Printed in House Ex. Doc. No. 290, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 4, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 29, 1895, from Capt. J. H. Willard, Corps of Engineers, of the results of a preliminary examination of Little River, Arkansas, from Fulton to White Cliffs, made to comply with provisions of the river and harbor act of August 17, 1894.

It is the opinion of Captain Willard, concurred in by the division engineer, Col. C. B. Comstock, Corps of Engineers, and by this office, that the river is not worthy of improvement by the General Government at the present time.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., January 29, 1895.

GENERAL: In compliance with instructions contained in letter from your office, dated August 20, 1894, I have the honor to submit the following report respecting Little River, Arkansas, from Fulton to White

Cliffs, a preliminary examination of which was called for by section 10 of the river and harbor act of August 17, 1894:

This stream has its source in the junction of Mountain and Gloves forks in the southeastern corner of Indian Territory, flows in a general southeasterly direction, and enters Red River about 3 miles above Fulton, Ark., having a total length estimated to be about 168 miles. White Cliff, Arkansas, is about 48 miles above the mouth, and 5 miles below Hoods Landing.

Little River has been examined by the United States four times, and all the reports have been adverse to its improvement by the General Government. The first examination was made by Captain Benyaurd, under provision of river and harbor act of June 18, 1878, and, respecting the stretch of river below White Cliff, he reported as follows:

Five miles below Hoods Landing we reach White Cliff, a shipping point for the back country some 6 or 8 miles distant. This cliff is a white limestone formation about 150 feet high. At one time lime of a fair quality was made here, but the place was abandoned on account of sickness. In the next stretch of 5 miles (or to the 43-mile point above the mouth) there is but one bad shoal, with only 0.8 foot in the channel. From the 43-mile point to the 36-mile point the river is but one succession of shoal places, with depth of water from 0.8 to 1.2 feet. At the 33-mile point another bad shoal occurs. This is about 800 feet long, with a depth of 1 foot through the channel. From this point to the mouth there is but one more shoal place, known as Granite Bar, 24 miles above the junction with Red River. This shoal is about 1,000 feet long with a depth of 1.4 feet upon it. It gives good water for 9 miles (above), averaging 6 to 10 feet depth. The bar is composed of large gravel and earth and extends entirely across the river, and appears up the banks on both sides as if it were regular strata. From Granite Bar to the mouth the navigation is very good, the water averaging from 12 to 15 feet in depth.

There is but little water in the river at its lowest stage. At the time the examination was made the water at Andersons Ferry (36 miles below the Indian Territory and Arkansas line) was about 3 inches above extreme low water. Considerable difficulty was experienced by the party in getting their skiff (which drew 4 inches, light) over the shoals, and in many places it had to be dragged. The total distance in ascending and descending the river, in which that had to be done, was fully 50 miles.

The obstructions in the stream are shoals and leaning timber. Nothing can be done to the shoals but attempting slackwater navigation, which, considering the amount of water in the river and the resources of the country, would not be justified. Since the shoals act as dams for the stretches of river above them, navigation would only be injured in attempting to cut through them.

* * * * * * *

There is but one settlement on the river, that a small place at Crooks, 40 miles above the mouth. Every place that has been started on the river has been abandoned on account of sickness. People who did not die moved back to the hills on each side, and haul their crops 40 to 50 miles to the different railroads. Taken altogether, I can not state to what amount the improvement of the stream would extend the commerce of the adjacent country. The prospects for settling along the banks of the stream is not a very inviting one. Back from the river on the south side the lands are said to be very good; on the north side they are hilly and very poor. (Report Chief of Engineers, 1879, pp. 990, 991.)

In October, 1882, Little River, between Hoods Landing and the mouth, was reexamined by Captain Handbury, in accordance with requirements of river and harbor act of August 2, 1882, who reported that he could suggest no method of improving its navigation except by locks and dams, which would be expensive, entirely local in their benefits, and not warranted by the present or even distantly future prospects of commerce of the river. (Report Chief of Engineers, 1884, p. 1407.)

The third examination was made under direction of Captain Taber, to comply with the requirements of section 6 of the river and harbor act of August 5, 1886, who reported that from the mouth to Hoods Landing the river met every demand of commerce. (Report Chief of Engineers, 1887, p. 1545.)

The last examination was made under my direction by Asst. Engineer John Ewens in April, 1893, in accordance with requirements of river and harbor act approved July 13, 1892, the report upon which will be found in the Report of the Chief of Engineers for 1893, pages 2087–2090, in which I gave the opinion that the river was not worthy of improvement by the United States, which was concurred in by the division engineer and yourself.

Assistant Engineer Ewens' examination extended from the head waters to the mouth, but developed nothing that would justify an expenditure for improvement of the stream. The obstructions below White Cliff were found to be shoals, as enumerated in the foregoing report of Captain Benyaurd. Mr. Ewens reported that lands along the stream suitable for agriculture were subject to overflow annually, and on the entire stretch traversed, from the Choctaw country to the mouth, he found but six habitations, and not a farm of any size on the river.

In 1878 the commerce of the river was reported to consist of a shipment of 3,200 bales of cotton, none of which was raised in the bottom lands, but all came from the hills back. In 1882 the yearly commerce was represented to be about 2,500 bales of cotton and a considerable quantity of timber, with between 4,000 and 5,000 tons of return freights, one small boat of about 70 tons doing all the business of Little River and Red River for 100 miles above and below Fulton, with no prospect that its capacity would be overtaxed. The little steamer engaged in this trade was burned in March, 1892, and the amount of business has not been sufficient to attract another boat since.

The White Cliffs Portland Cement and Chalk Company has been incorporated for the development of the resources of the country adjacent to White Cliffs, Arkansas, by the manufacture of chalk, cement, brick, lumber, etc., and the president, Mr. Lewis Metesser, informs me that the item in the act of August 17, 1894, calling for a reexamination of Little River was inserted at the solicitation of that company. In August, 1894, I wrote Mr. Metesser, inclosing the usual blank form, asking information respecting the amount of commerce of the stream, present and prospective, and, under date of September 21, 1894, he replied as follows:

[White Cliffs Portland Cement and Chalk Company, White Cliffs, Arkansas.]

No. 34 St. Charles Street,
New Orleans, September 21, 1894.

Dear Sir: In addition to ours of the 1st instant in acknowledging receipt of yours of the 31st ultimo, we are now able to send you, as then stated, a condensed outline of our enterprise, for which we desire to use Little River, from White Cliffs to its mouth, in Arkansas. This matter we send you under separate cover by same mail as this, which we trust will give you a general idea of the traffic that may be expected in the future. We will probably find it necessary to run heavy machinery up by boat from Fulton as early or sooner than January 1, 1895.

Since writing you on the 1st instant, we have endeavored to get some reliable information to enable us to fill out the blank that you send, but have not been able to do so. We have consulted steamboat captains who have for years been on upper Red River and Little River as high up as White Cliffs, but from none of these can we get any business statement. In other words, they all say, "We have taken out large quantities of freight," but when endeavoring to get from them even an approximation for a number of years, we have failed to do so. You probably know this class of men better than we do, therefore appreciate why we have failed. Whatever the past may have been, we feel satisfied that if the river can be put into navigable shape it will be to the interest not only of our enterprise, but all others that will follow, and to such an extent that it will justify the General Government to make the necessary improvements.

In our previous letter we asked whether we can have the privilege of going over the river at the time that your engineer would make the investigation authorized in the recent act, to which you did not reply; we therefore repeat the question, whether it will be permissible for us to then and there be represented. We would like very

much if this can be arranged, as we will prefer to make such examinations we will make ourselves at the time and under the advice of your engineer. If one time is as convenient as another to you to have this examination made, and we will be permitted to be represented, we would ask that you allow us to confer with you as to time, so we we can arrange our part of it.

Trusting that this necessarily incomplete statement, in connection with our printed synopsis, will enable you to act favorably on the matter, and that we may hear from you at your earliest convenience, we are,

Respectfully, yours,

WHITE CLIFFS PORTLAND CEMENT AND CHALK COMPANY.
L. METESSER, *President.*

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

The synopsis referred to in the foregoing letter contains analyses of the chalk and clay at White Cliffs and an outline of the enterprise, but no definite basis for estimating the commerce to be benefited by improving Little River. The following extract is taken from this synopsis, under the head Transportation:

Little River, upon both banks of which, as above stated, the property is located, is a navigable stream, subject to the laws of the United States for such water courses, and with very little work, for which the present river and harbor bill provides the beginning, it will enable the shipping of the entire product of our works and of the other manufacturers. For over fifty years White Cliffs Landing has been used by steamboats, loading cotton and the other crops of the surrounding country.

Two separate lines of railroads are within a short distance of White Cliffs, the managers of which will made the necessary connections whenever requirements justify.

In addition to the above existing river and railroad facilities, the articles of the company's incorporation permit building both private and public railroads, which, if carried out by building two short pieces of road, will place White Cliffs in independent connection with the Mississippi River at Arkansas City and Texarkana, where the competing rates, by river from Arkansas City and the six roads (four of which are trunk lines) and their connection centering in Texarkana, will make the enterprise independent by both rail and by water routes.

To provide shipping facilities for and to connect the various manufacturing plants of the enterprise with the chalk and clay deposits, timber, river, public railroads, etc., and for the public use, the required wharfs, tramways, railroads, and steamers will be constructed, equipped, and operated and arranged to connect with public railroads and steamboats, and will have the terminals on the company's land and wharfs.

The lower portion of Little River usually is navigable at stages high enough to permit Red River boats to run from Shreveport, La., to Fulton, Ark., and, in view of the facts and reasons herein set forth, it is my opinion that it is not worthy of improvement by the General Government at the present time, and that a further examination or survey is not required.

Very respectfully, your obedient servant,

J. H. WILLARD.
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, February 1, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by Captain Willard, I concur in the opinion that this river is not worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

U 21.

PRELIMINARY EXAMIMATION OF BŒUF RIVER, ARKANSAS, ABOVE WALLACES LANDING.

[Printed in House Ex. Doc. No. 350. Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 1, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated February 21, by Capt. J. H. Willard, Corps of Engineers, of the results of a preliminary examination of Bœuf River, Arkansas, above Wallaces Landing, required by the river and harbor act of August 17, 1894.

It is the opinion of Captain Willard, concurred in by Col. Henry M. Robert, Corps of Engineers, the division engineer, and by this office, that Bœuf River above Wallaces Landing is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 21, 1895.

GENERAL: In compliance with instructions contained in letter from your office, dated August 20, 1894, I have the honor to submit the following report respecting Boueff [Bœuf] River, Arkansas, above Wallaces Landing, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894.

Bœuf River has its source in Chicot County, southeastern Arkansas, a few miles west of Bayou Maçon, and, flowing in a general southwesterly direction, enters Ouachita River at Stafford Point, 8 miles above the town of Harrisonburg, in Catahoula Parish, La. An examination of this stream was made under the direction of Major Benyaurd, by Assistant Engineer H. St. L. Coppée, in October, 1880, in accordance with requirements of section 2 of river and harbor act approved June 14, 1880. (Report Chief of Engineers, 1881, pp. 1424–1428.) Major Benyaurd reported as follows:

> The examination was made by Mr. H. St. L. Coppée, assistant engineer, whose report will be found annexed, and was made with a view of determining the character and extent of the obstructions to navigation, with estimated cost of removing same, and the nature and extent of the commerce to be benefited.
>
> The stream was examined from the State line between Arkansas and Louisiana to its junction with the Ouachita, a distance of 346 miles. The upper reach of the river for a distance of 66 miles—that is, from the State line to Wallaces Landing—is made up of numerous small lakes, connected by short stretches of river, which in many places are not over 20 feet in width. This part of the river may be compared more to a swamp, and is so obstructed by snags, logs, stumps, etc., and the commercial advantages to be gained by improving the same, even for high-water navigation, are so small in comparison to the amount required for the work, that it is not deemed advisable to consider this part of the river as desirable to be improved. The land in this section is susceptible of a high degree of cultivation, but the constant liability

of destruction of the crops, due to breaks in the Mississippi levees in the State of Arkansas, causes the lands to be abandoned.

From Wallaces Landing to the mouth, a distance of about 280 miles, the river is obstructed by snags, logs, and overhanging timber. For the present it is only deemed advisable to improve the navigation by removing these obstructions, which will allow boats to ascend to Wallaces Landing during that portion of the season when the water in the bayou is only sufficient for boats of the lightest draft.

The amount of cotton shipped annually from the bayou is estimated at 17,000 bales, valued at $850,000, to which must be added return freight, etc., to almost an equal amount. From the upper portion of the stream the products find a market in New Orleans, via the Vicksburg and Shreveport Railroad, to Delta, and thence down the river by boat. The charge per bale to New Orleans by this route is $2.50; by boats directly down the bayou, when the stage of water admits, $1.50. Were the stream improved by the removal of the obstructions above noticed, the crop of cot ton and other products would be greatly increased.

Respecting the river above Wallaces Landing, Assistant Engineer Coppée reported as follows:

The Bœuf River, which I examined from the State line dividing Louisiana and Arkansas to the mouth, I shall, for convenience of description, divide into two parts: That portion from the line to Wallaces, or the first reach, being closed by logs, rafts, drift, etc., and very difficult to improve for navigation; and a second reach from Wallaces to the mouth, which differs in every respect, having been navigated for some years past at a stage of about 7 feet above low water.

From what I could gather, I judge the river to be at the time of this examination about 3 feet above low-water mark, i. e., the lowest water known, and falling

FIRST REACH.

The Bœuf River at the State line is about 20 miles in a direct line from and west of the Mississippi River. The stream 3 miles above the line is in the form of a lake, quite wide and deep enough to float the largest river boats, but at a point half a mile below, called the Shingle House Crossing, it scatters into numerous branches narrow and shallow enough to ford at low water, and exists in that condition until the Ashton Road Crossing is reached, 4 miles below the State line; thence the stream begins to collect its branches, and where they finally come together there is a raft of logs, drift, etc., probably 1,000 yards through.

From the Ashton Road Crossing the river again takes the form of a lake, averaging 150 feet wide by 13 feet deep by 4 miles long. This lake contains about 30 snags, 15 logs partially, and in places entirely, across the stream. Should improvements be attempted the overhanging trees would also have to be cut down. The lake is comparatively straight, i. e., the bends are not sharp or narrow. From the foot of the lake for a distance of 8 miles the stream is very crooked, and difficult, at the present stage of water, to navigate even with a skiff. In many places cypress trees stand directly in the channel. The width varies from 20 to 100 feet, and the depth from 9 to 3 feet. Forty logs or fallen trees cross the stream at different intervals, causing rafts and heavy drift piles to form, making it impassable. In this stretch I counted 60 snags and 9 large cypress stumps. The shoals (3 feet of water at the present stage) are also very numerous. These shoals are caused by sand bars forming below the narrow bends. In case of improvement a great number of overhanging trees would have to be cut. From this point, which is 16 miles from the State line, to Wallaces, 50 miles farther by river, the stream is a continuation of lakes and narrow bends following each other successively. The lakes, which vary from one-fourth to 2 miles in length, have an average depth of 5 feet, width of 100 feet, and but little current.

At the end of each lake there is generally a mile or more of sharp, horseshoe bends, in places the river being not over 20 feet wide by 2 feet deep, containing sand bars, rafts, drift piles, trees, and stumps standing in the channel, and every few hundred feet a cypress log stretching from bank to bank. Between the lakes or straight open stretches the current is considerably accelerated.

The river in the upper portion of this first reach runs through a swamp, about 4 miles wide, lying between the Macon hills and the high lands east of Bayou Bartholomew, whereas through the lower portion the country is higher, the bank being usually about 17 feet high.

The soil is of a sandy composition, the bank in some places showing thin strata of clay, the surface of the adjacent country being of the same nature. The river bed is generally a hard, compact sand.

The timber throughout the reach varies, that at the upper end being superior in quality and quantity. One mile west of the river, at the State line, there is a strip of good pine 2 miles wide by about 15 miles long, running southeast.

The entire reach contains cypress, many varieties of oak, such as white, cow, black, red, overcup, pin, etc.; hickory, gum, elm, and ash are also found. The timber which principally fringes the river is cypress and oak.

COMMERCIAL STATISTICS.

The land adjacent to the Bœuf, for some distance both above and below the State line, is capable of high cultivation, but owing to the sickliness of the climate and the liability to overflow it is but little worked. The plantations or clearings east of the Shingle House, on the Maçon hills, are many of them deserted. The planters at present average about 15 bales of cotton apiece. Should this upper portion of the river be opened to navigation the acreage of cultivated land would be greatly increased. The products of the country west of and in the vicinity of this reach of the Bœuf pretty much all find an outlet by way of the Bartholomew, and probably would do so were the stream made navigable. The products on both sides, from the Shingle House as far south as Wallaces, would amount to about 300 bales of cotton per annum, and even some of this might be shipped by the Maçon in preference. Most of the produce would come from Oak Grove, on the Maçon hills and Shilling's neighborhood, near the river; the cattle trade would be but light, owing to the great loss incurred at overflow times.

In my estimation, the great outlay necessary to make this 66 miles of river navigable, even at high water, would hardly be compensated for by the little cotton (300 bales), seed, cattle, etc, that the country would produce.

The unhealthy and present backward condition of this section, in a great degree, is due to overflows. These, from some time before 1842 until after 1864, did not occur, because of the good condition of the levees bordering the Mississippi River; but during the late rebellion these were destroyed in many places, so that since, at every overflow of the Mississippi River, all this country lying between the Ouachita and the Mississippi is inundated, excepting the high ridges, probably 16 feet above high-water mark, such as Maçon hills, etc. The principal breaks necessary to rebuild in order to protect this Bœuf country are in the Matthews Bend Levee, which I am told an 8-foot levee would protect, and the Possum Fork. The Ashton break would affect the Maçon and Tensas, but not the Bœuf, owing to the intervening hills.

The oscillation of the Bœuf is about 30 feet, the time of rising and falling corresponding very nearly with the Mississippi River; the planters look for high water in December and low water in the summer and fall.

Work for the removal of snags, logs, leaning timber, etc., obstructing navigation at high stages below Wallaces Landing, has been carried on, when funds were available for the purpose, since 1881, in accordance with Major Benyaurd's project of 1880. The river and harbor act of 1884 directed an examination of three outlets near Point Jefferson, about 19 miles below Wallaces Landing, which was made by Captain Bergland that year, and he recommended that the outlets be closed to preserve navigation in the stream; the cost of the work then needed was estimated at $7,290. The next river and harbor act authorized this addition to the original project, but provided only $5,000 for "continuing improvement and for closing Outlet No. 1." Being hampered by lack of funds, these outlets were not closed until the low-water seasons of 1887 and 1888, and it would have been impossible to do the work then except for pecuniary aid and labor given by the planters whose lands would be protected, the proportion of cost borne by the United States having been $5,441.78. Outlet No. 1 was closed substantially, No. 2 was closed by a heavy dam, and No. 3 by a low dam, which was all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. The closure of the outlets gave immediate benefit to navigation by confining the flow to its natural course and by scouring the bars below, but the willful cutting of Opossum Fork Levee in the spring of 1890 and the crevasses that occurred in the Arkansas levees along the Mississippi below, admitted an immense volume of water into the secondary valleys drained by Bœuf River and the Tensas and Maçon, which swept away all of the dams closing the outlets. Subsequent appropriations have been too

small to replace the work, and its cost is increased by each flood, the last estimate, made by me, for the purpose amounting to $30,000.

When the examination of this stream was made in 1880 the Vicksburg, Shreveport and Pacific Railroad, crossing it at Girard, La., was the only competing route of transportation; but the New Orleans and Northwestern Railway has been completed recently from Natchez, Miss., to Bastrop, La., crossing the river about 2 miles north of Rayville, La., and the Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific system, built a few years ago, runs a few miles west of and parallel to the river from its headwaters as far south as Columbia, Caldwell Parish, La. Another line, the Louisiana, Arkansas and Missouri Railroad, is projected, which will touch the stream at several points on the east.

Railroad competition and repeated overflows, caused by defective levees along the Arkansas front of the Mississippi, have diminished the commerce of Bœuf River, as shown by the following summary of what has been reported to this office during the last six years, taken from my annual report for 1894.

Summary of commerce reported.

Articles.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	900	626	1,583	1,760	1,397	1,084
Cotton seed	2,550	1,878	1,178	716	731	834
Hides and skins	.....	.....	50	.....	.....	.....
Live stock	12	.....	19	.....	.....	.....
Lumber	300	250	1,352	.....	.....	.....
Saw logs	.....	.....	1,223	.....	.....	.....
Staves	4,626	923	3,138	1,777	263	54
Miscellaneous	450	300	72	179	.....	91
Total down freight	8,838	3,977	8,615	4,432	2,391	2,063
Return freight	650	335	1,370	3,458	1,594	1,376
Total	9,488	4,312	9,985	7,890	3,985	3,439
Estimated value	$350,000	$200,000	$501,000	$636,500	$580,850	$457,100

So far as I have information, there has been no steamboat as high as Wallaces Landing since I was assigned to charge of this district in 1886, and probably none has been above Point Jefferson since the work commenced in 1881, the latter place being considered the head of high-water navigation. At the close of operations of the fiscal year 1894, Overseer Watkins Decker, who had been in local charge of the work, reported that the extension of the New Orleans and Northwestern Railway from Rayville to Collinston, La., where it connects with the Houston, Central Arkansas and Northern Railroad, had diverted a large portion of the commerce of the stream, which would be still further decreased. He was informed by Capt. L. Brunner, of the steamer *Parlor City*, that it was doubtful whether boats in future would run above Mrs. Jordan's Landing, about midway between the New Orleans and Northwestern Railway Bridge and Point Jefferson and about 33 miles below Wallaces Landing. Overseer J. R. Vaughan, who has been in local charge of the work done between Wallaces Landing and Charlieville the past season of low water, reported on the 2d instant as follows:

The country adjacent to the river above Point Jefferson to Wallaces Landing is nearly all woodland, there being only a few acres cleared. The timber consists of gum, white oak, ash, cypress, and hickory, the latter of an inferior quality. About

100,000 staves are on the banks awaiting transportation. Below Point Jefferson to Mrs. Jordan's there are only a few small farms, and all their produce has been shipped by railroad. From Mrs. Jordan's to the Vicksburg, Shreveport, and Pacific Railroad Bridge, at Girard, and thence downstream to Charlieville, about 55 miles, productive plantations join each other along the banks, but the greater portion of their crops was shipped by railroad as soon as it was ready for market. From the best information I can get, from Messrs. Wright, large planters above Girard, and Messrs. McCaskill and other large planters below that place to Charlieville, there are only about 1,000 bales cotton awaiting shipment by boat, most all going to New Orleans, the saving by river freight being 85 cents per bale. About 1,100 tons cotton seed also are awaiting shipment by boat, nearly all of which will go to the oil mills at Monroe.

From the foregoing information it appears that there is no public necessity or convenience to be subserved by improving Bœuf River above Wallaces Landing, the upper portion of which runs through a swamp about 4 miles in width and the entire stretch consisting of a succession of pools and shoals, the latter being dry, or nearly so, at lowest stages. This part of the river at present is impassable by reason of trees, snags, logs, and raft in the channel, and overhanging timber. If these obstructions were removed it is doubtful if steamboats could be induced to run, as the river could be made navigable by this means for the highest stages only, and, owing to the uncertainty of navigation, it is probable that shipments of the limited commerce of the locality would continue by railroad or by bayous Bartholomew or Maçon. During the fiscal year 1894 there was only one steamboat trip reported as high as Point Jefferson, Jordan's Landing having been the upper limit ordinarily. The channel below the outlets of Point Jefferson is shoaling rapidly, and until the outlets are closed substantially and there is reasonable assurance of levee protection from the floods of the Mississippi along the Arkansas front below Arkansas River it would seem inadvisable to continue the improvement as high as Point Jefferson.

As in the case of Bayou Maçon above Floyd, report upon which is submitted this date, the desire for the removal of obstructions in Bœuf River above Wallaces Landing appears to be for the purpose of providing a drain for flood water of the Mississippi from the lower counties in southeastern Arkansas more than for securing an extension of the navigable portion of Bœuf River, and for the reasons given in that report and those herein it is my opinion that Bœuf River above Wallaces Landing is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Henry M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, February 28, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons given by the district officer I am of opinion that Bœuf River above Wallaces Landing is not worthy of improvement by the United States.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

U 22.

PRELIMINARY EXAMINATION OF BAYOU MAÇON, ARKANSAS, ABOVE FLOYD.

[Printed in House Ex. Doc. No. 349, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 1, 1895.

SIR: I have the honor to submit the accompanying copy of report by Capt. J. H. Willard, Corps of Engineers, dated February 21, 1895, of the results of a preliminary examination of Bayou Maçon above Floyd, Ark.

Captain Willard is of the opinion that this locality is not worthy of improvement by the General Government, and his views are concurred in by Col. Henry M. Robert, Corps of Engineers, division engineer, and by this office.

Very respectfully your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 21, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Bayou Maçon, Arkansas, above Floyd, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894:

This stream has its source in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles west of the Mississippi, flows in a general southerly direction west of and nearly parallel to Tensas River, and enters the latter in Franklin Parish, La., about 40 miles above its mouth. Below Floyd, La., to its mouth, estimated to be about 98 miles, work has been carried on when funds were available for the purpose since 1884 in conjunction with the improvement of Tensas River.

Under the requirements of section 2 of river and harbor act approved June 14, 1880, an examination of Bayou Maçon was made that year by Assistant Engineer F. S. Burrowes, under direction of Major Benyaurd. (Report Chief of Engineers, 1881, pp. 1462–1467.) This examination was made at a stage about 2 feet above lowest water, affording a good opportunity to observe obstructions to navigation, and respecting the portion of the bayou above Floyd, Mr. Burrowes reported as follows:

> Entering the bayou at Eudora Ferry, 4½ miles west of Grand Lake, Ark., on the Mississippi River, I examined it for about 10 miles above, and found it about 70 feet wide, 3 feet deep, and so filled with snags, sunken logs, and large cypress stumps as to make it almost impassable with a skiff. From this point to its source is quite a long distance, but it is so narrow, shallow, and filled with obstructions that its improvement would be impracticable, and, from its close proximity to the Mississippi River, unnecessary.

Coming back to Eudora Ferry and floating down, I found the distance to Floyd to be 70 miles by the bayou, and its general characteristics about as follows:

At Eudora Ferry the stream is 75 feet wide and continues this width with an average depth of 5 feet for about 10 miles, bending only at long intervals. At the end of this portion an island, or bar, 300 feet long has formed, which leaves a channel on either side 30 feet wide and 2 feet deep. After this is passed the bayou again assumes the same width and general lake-like character as above, and continues thus for a distance of 5 miles, when it becomes very crooked, narrow, and shallow. Down to this point there are about 20 large snags to the mile, besides a great number of sunken logs and several oak and gum trees stretching clear across the channel. The timber along this portion, composed of oak, hickory, gum, and pecan, is dense and continuous, and owing to the narrowness of the channel forms an obstacle which would have to be removed to make it navigable. The bayou then continues crooked, narrow, and shallow as far as Nashs Ferry, 35 miles below Eudora Ferry. This portion is filled with snags and sunken logs, which collect in the bends and form impassable rafts from 200 to 300 feet long. The timber along the banks also changes in character, becoming largely heavy cypress, which leans over the bayou, and which, together with the numerous large stumps of the same timber found in the channel, forms a formidable obstacle to its improvement here.

Fifteen miles above Nashs Ferry and 4 miles below the line between Arkansas and Louisiana the Maçon is crossed by a road leading to Ashton Landing, on the Mississippi River, which is only 2½ miles distant from it at this point.

Below Nashs Ferry the bayou widens to 150 feet, has a depth of 6 feet, is nearly straight, and singularly free from obstructions, both in the channel and on the banks. It continues thus for 15 miles. From this point to Floyd, a distance of 20 miles, it again becomes very crooked, narrow, and shallow, being only 100 feet wide and from 2 to 4 feet deep. The leaning timber on this reach, which it would be necessary to cut in order to make the bayou navigable, is very heavy and thick, without, however, including much cypress. The snags in the channel are very numerous, averaging about 25 to the mile, and the bed of the stream is a perfect network of sunken logs. These obstructions, along with a very swift current, make this portion difficult to navigate, even in a skiff.

The bed and banks of the bayou above Floyd are composed of the same hard red clay as the Maçon hills, covered with from 3 to 5 feet of rich alluvial deposit. The banks are very uniformly 22 feet in height, and overflow from 6 to 8 feet at time of high water in the Mississippi.

There are a number of small tributaries to the upper portion of the Maçon, none of which, however, are of much importance. The largest are the following: Ditch Bayou, an artificial channel connecting the bayou with Lake Chicot, Arkansas; Rush Bayou, entering the Maçon at Eudora Ferry and connecting it with Grand Lake, Arkansas; Rowen Bayou, entering at Ashton Ferry and connecting the bayou with the Ashton break in the levees on the Mississippi River.

The water in the Maçon, I understand, reaches its lowest stages in the early fall, begins to rise about December 1, and remains from 6 to 18 feet above low water for about eight months thereafter. It never of itself rises sufficiently to escape from its banks, so that as long as the Mississippi levees opposite its headwaters were continuous the bottom lands could be cultivated without danger of overflow. Since the breaks in the levees at Ashton, Matthews Bend, and Possum Fork the Mississippi, at time of high water, pours into and floods this whole section, raises the level of the Maçon 30 feet above its present stage, and in fact turns it into a high-water chute of the main river. For this reason farming along the bayou at the present time, except on the hills, is precarious and generally unprofitable.

In my opinion, it would be inexpedient to attempt to make navigable any portion of the Maçon above Floyd, as, from the number and nature of the obstructions and the narrowness and shallowness of the channel, the expense of such improvement would be very great and largely in excess of the benefits conferred on the country along it, for the following reasons:

First, as stated above, all, or nearly all, the land under cultivation along this portion of the bayou is on the hills, from all parts of which shipping points can be found within a reasonable distance, either at landings on the Mississippi or at Floyd, on the Maçon.

Second, the improvement of this part would not increase the acreage under cultivation in the bottom lands, as they remain unimproved, not from want of a convenient shipping point, but, as stated, from their liability to overflow by the Mississippi.

In submitting the report of examination Major Benyaurd made the following statements, viz:

In presenting the estimates for the improvement of the Maçon I have not deemed it necessary to consider the upper section of the stream, extending as far down as

Floyd, La., a point some 40 miles below the State line, from the fact that this section is so filled with snags, logs, stumps, and other obstructions that scarcely a skiff can be got through it, and the cost of making a navigable channel will be so greatly in excess of any benefits likely to be derived from its improvement. In addition, the proximity of the Mississippi River, to which the crops can be hauled, is likely to render the improvement unnecessary. I will, therefore, only consider the river from Floyd, the present head of navigation, to the mouth.

The examination showed that, like all streams in that section of the country, the main obstructions to navigation are snags, sunken logs, and leaning timber, the removal of which will constitute the principal work to be carried on with a view of improving the stream and of giving increased facilities for the shipment of cotton and the return of plantation supplies and other freights. Were any other system of improvement carried on it would have to be a system of locks and dams, which the commerce of the adjacent country would not at present justify.

Floyd is the only town on the Maçon. It is the county seat of West Carroll Parish, and contains about 250 inhabitants. The amount of cotton shipped from this point is said to be 3,000 bales. It is the present head of navigation, boats running regularly to the place about five months in the year. Some of these make round trips to and from New Orleans; others connect at Trinity with the Ouachita River boats.

The amount of cotton shipped from the bayou by steamer amounts to about 9,000 bales annually. Other amounts go by way of the Vicksburg and Shreveport Railroad to Delta, and thence by boat to New Orleans. Were the bayou improved, the running time of the steamers would be increased about three months, and nearly all the cotton raised would find an outlet through the river at reduced rates of freight.

The lands through all this section of upper Louisiana are susceptible of a high degree of cultivation, but the breaks in the levee along the Mississippi front in Arkansas, while doing no particular damage to that State, cause the lands in north Louisiana to be inundated every high water. Were these breaks repaired, all the now abandoned lands in this section of the State would be brought under cultivation. This work, combined with the improvement of the streams like the Bœuf, Maçon, and Tensas, which would facilitate the shipment of the crops, would add greatly to the production of cotton and other crops.

The first appropriation for this bayou was made by river and harbor act of 1884, which provided $4,000 for improving Tensas River and Bayou Maçon, Louisiana. Subsequent acts have appropriated funds for continuing work in both streams, the total amount from 1884 to the present time aggregating $28,000. The portion of this sum applied to improving Bayou Maçon below Floyd, in accordance with the foregoing project, is $20,153.12, with which the stream has been put in fairly good navigable condition, enabling steamboats to make quicker trips to Floyd during the navigable season, about seven months of the year, with comparative ease and safety.

Major Benyaurd's estimate for removing the obstructions by five months' work in one low-water season was $17,000, but at no time was more than $5,000 provided for both streams, and as new obstructions are added each year, small appropriations are needed from time to time to maintain what has been done in the interest of safe navigation. As no work has been done above Floyd, the upper portion of the bayou still is unnavigable, and the growth and accumulations of obstructions during the last fourteen years have rendered its improvement more expensive and unprofitable than when reported upon in 1880.

Major Benyaurd reported in 1880 that the amount of cotton shipped from the bayou by steamer was about 9,000 bales annually, or, say, 2,200 tons. This is largely in excess of the commerce reported to this office the last two years from both Tensas River and Bayou Maçon, as shown by the following table, taken from my annual report for 1894:

Summary of commerce reported, Tensas River and Bayou Maçon, Louisiana.

Articles.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.	1888–89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	450	498	3,762	2,760	1,527	2,750
Cotton seed	1,400	1,457	4,876	4,850	2,920	4,009
Hides and skins	2	3	.....	10	2	5
Live stock	108	3	10	6	.....	225
Staves	895	26	71	1,032	3,325	3,500
Lumber	300	.....	440	.....	.....	.....
Miscellaneous	104	.....	1,942	378	50	1,823
Total down freight	3,259	1,987	11,101	9,036	7,824	12,303
Return freight	2,700	662	5,886	6,000	5,216	8,202
Total	5,959	2,649	16,987	15,036	13,040	20,505
Estimated value	$389,000	$122,500	$990,000	$999,500	$742,390	$1,194,100

The falling off in freights probably was due to some extent to railroad competition, but the rapid decrease in the last two years was caused by lack of proper levee protection against the floods of the Mississippi in Desha and Chicot counties, Ark. In 1892, previous to the culmination of the flood of that year, it was estimated that the line of levees extending from the Louisiana line to Amos Bayou in Arkansas, about 85 miles, had over 40 per cent of its length weak and of small section, with grade less than a foot above height of previous floods. The flood of 1892 was higher along this entire line than in 1890, fully 1 foot in places, and six crevasses occurred. The discharge from these crevasses, with a larger volume of water, mostly from Arkansas River, which crossed Amos Bayou ridge above the head of the levee system, found an outlet down the Maçon and Tensas, and Bœuf River, inundating the bottom lands and preventing a crop. The same thing occurred to a somewhat lesser extent during the flood of 1893.

The ridge formed by the bank of Amos Bayou, on which the levee system terminated, formerly was considered above overflow, but extreme high stages of the Arkansas River, when not restrained by levees, have overflowed this ridge, as in 1890, 1892, and 1893, and to protect its people the State of Louisiana has built an extension of the levee system up the ridge on the northeast bank of Amos Bayou, about 6½ miles, with the hope that this work, with the repairs recently made to the levees on the Arkansas and their extension southward by the United States, will afford protection against floods from that direction. The State of Arkansas seems unwilling to furnish proper aid for protecting its own people and those of a sister State against the flood waters of the Mississippi, and the only argument for the improvement of Bayou Maçon above Floyd appears to be that in case of overflow it would drain the country contiguous more rapidly at the expense of those living farther down the stream. A letter from Mr. D. H. Reynolds, of Lake Village, Ark., received at this office August 14, 1893, confirming this opinion, is given below:

LAW OFFICE OF D. H. REYNOLDS,
Lake Village, Ark., August 9, 1893.

DEAR SIR: When in Vicksburg a few days ago to attend the delegated convention of the levee districts in the Tensas Basin I intended to call on you to have a talk about the expenditure of the $5,000 appropriated for continuing the improvement of the Bayou Maçon in Louisiana and Arkansas. I desired to have such talk before introducing the resolution in the convention in regard to the matter, and so that there might not be any apparent wish to have the money expended in a manner different from your wishes, or without first consulting with you about it, for it may be that the money was intended to be expended as the convention requested. But

when the convention met it was so harmonious that the matters to be considered were speedily adjusted; and as the steamer was at the landing, I desired to take it to come home, and so I could not call, and I requested Major Richardson and Judge Pindall, who were going to remain longer, to see you in my behalf. If it may be done, I think that by expending the $5,000 in cutting out the drift and standing timber for the width of, say, 100 feet the cutting could be extended far up the bayou, and it would permit the continued uninterrupted and rapid flow of the water in the bayou, and so carry off a much greater quantity of water than now runs in it within a given time. The 100 feet would not be wide enough, but would do to begin, and it would reach a longer distance. This will be work to be done in any event when the bayou is improved in Arkansas, and we will at most only be hastening the expenditure there. It may be that the money was not specifically named in any estimate for the work now suggested to be done in the channel of the bayou in Arkansas; but certainly the spirit of the appropriation would justify such expenditure.

If it shall be necessary for the approval of your seniors to be had before the $5,000 can be expended as requested by the convention at Vicksburg, then if anything can be done on the part of the levee authorities immediately interested, and that made the request, if you will indicate it I will be pleased to move in the matter. The people in the locality affected are impressed with the, to them, great importance of having the drift and standing timber cut and removed from the bayou. They are trying every effort, so far as their means will allow, to secure protection and relief from floods in future; and they believe that the expenditure of the $5,000 in cutting the drift and timber in the bayou in Arkansas will relieve much from a break in the levee, in the event we have one as in this year. The flood line of the overflow would have been very greatly reduced in the Tensas Basin this year if the drift and timber had not obstructed the channel of the bayou. So much (for the people in the overflowed districts of the Tensas Basin) depends upon the basin being kept free from floods for a few years that they desire to use every available and possible means during this season to ward off and so far as possible relieve against any floods that may come next year. So to speak, they desire to call on the reserves in the present emergency and try and secure protection.

On behalf of this, by flood, nearly impoverished people I bespeak your kind offices and your aid in securing for them the protection they seek. You are in a position to know what to do and how to do it, and we hope you will do for this Tensas Basin in way of protecting it from floods all that may be done with the limited means at hand, by removing the standing timber and drift from Bayou Maçon and from Bœuf River. And if we in the basin can in any way aid or facilitate the good work, command us. I would be pleased to hear from you about this matter.

Respectfully, etc.,

D. H. REYNOLDS.

Capt. J. H. WILLARD,
United States Engineer.

NOTE.—When the river and harbor bill was before the committee I wrote to Mr. Cate, the member of Congress from this district, urging him to try and have an appropriation to cut the timber and drift in Bayou Maçon in Arkansas, but it was so late, etc., that the most that could be done was to get the committee to add the words "and Arkansas" after the word "Louisiana" in the item; but even that indicated a willingness for the money to be expended in Arkansas, and for the purpose for which such expenditure was urged.

The facts are summarized as follows: Bayou Maçon above Floyd is only a few miles west of the Mississippi River, varying in distance from 2½ to 15 miles; nearly all the cultivated lands along it are on the hills from which shipping points can be had within reasonable distance, either at landings on the Mississippi or at Floyd. It is crossed near Arkansas City by a branch of the Missouri Pacific Railway system, connecting with the Mississippi River and Illinois Central Railroad, on the east and another branch of the Missouri Pacific on the west, which runs southwest along Bayou Bartholomew to Monroe, La., and thence to Alexandria. The stream is narrow, shallow, and so filled with snags, logs, drift, and timber that it is unnavigable at any stage, and while the removal of these obstructions might permit boats to make occasional trips at high stages of water for a short distance above Floyd, the cost of the work required and its maintenance from time to time is not commensurate with any commerce that possibly might develop at some future time.

For these reasons, it is my opinion that Bayou Maçon above Floyd is not worthy of improvement by the General Government, there being neither present nor prospective demands of commerce sufficient to justify any expenditure for the purpose.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Henry M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, February 28, 1895.

Respectfully forwarded to the Chief of Engineers.

For the reasons given by the district officer, I am of opinion that Bayou Maçon above Floyd is not worthy of improvement by the United States.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

U 23.

PRELIMINARY EXAMINATION OF YALLABUSHA RIVER, MISSISSIPPI.

[Printed in House Ex. Doc. No. 351, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 1, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated February 23, by Capt. J. H. Willard, Corps of Engineers, respecting a preliminary examination of Yallabusha River, Mississippi, required by the river and harbor act of August 17, 1894.

It is the opinion of Captain Willard, concurred in by Col. Henry M. Robert, Corps of Engineers, the division engineer, and by this office, that this river is not worthy of further improvement by the United States.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 23, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Yallabusha River, Mississippi, a preliminary

examination of which was called for by section 10 of river and harbor act of August 17, 1894.

An examination of this stream and a project for its improvement were made by Major Benyaurd in 1879, his report being given in full below:

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 20, 1879.

GENERAL: I have the honor to submit the following report upon an examination of the Yallabusha River, Mississippi, provided for by act of Congress approved March 3, 1879, and assigned to me by letter of April 25, 1879.

The examination was made by Mr. W. M. Rees, assistant engineer, whose report will be found annexed, and was made with a view of determining the character and extent of the obstructions to navigation, with estimated cost of removal and the nature and extent of the commerce to be benefited.

The Yallabusha is a small stream (estimated to be about 90 miles in length), and has its source in Calhoun County. After flowing through Grenada and Leflore counties it unites with the Tallahatchee and forms the Yazoo River. The examination shows that, like all the streams in that section of the country and in the Yazoo Basin, the main obstructions to navigation are snags, sunken logs, and leaning timber, the removal of which constitutes the principal work to be carried on with a view of improving the navigation of the stream and of giving increased facilities for the shipment of cotton and the return of plantation supplies and other freights.

The country through which the Yallabusha runs is very sparsely settled, and in a number of places the land adjoining the river is inundated at a high stage of water. The shipments are mainly from the plantations back from the river.

Under the present condition of affairs Grenada is the principal shipping point, from which place annually the amount of cotton shipped is estimated at 12,000 bales. The greater portion of this finds its way by rail to New Orleans. The shipment by river last season amounted from 3,000 to 3,600 bales. Were the river improved, no doubt the greater portion that now goes by rail would find its way out by boat, and at reduced rates of freight.

In the present condition of affairs it is deemed only necessary to cut down the leaning timber and remove the rack heaps and the most dangerous snags. For this purpose no snag boat is necessary. During the lowest stage of water a party can be sent along the river with the necessary tools, etc., and everything can be cut out.

The estimated cost of this improvement is $7 000.

Very respectfully, your obedient servant

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A

REPORT OF MR. W. MARSHALL REES, ASSISTANT ENGINEER.

MEMPHIS, TENN., *December 11, 1879.*

MAJOR: I have the honor to submit the following report upon an examination of Yallabusha River, Mississippi, made under instructions received from you December 2, 1879:

On December 3 I proceeded, with a skiff and two experienced skiffmen, to Grenada, Miss. December 4 and 5 being rainy, I started down the river on the 6th and reached its mouth on the 8th, a distance which I estimate to be about 90 miles.

The Yallabusha River has its source in Calhoun County, and, flowing through Grenada and Leflore counties, unites with the Tallahatchee to form the Yazoo River at a point 4 or 5 miles above Greenwood, Miss., and about 260 miles from the mouth of the Yazoo.

Five miles above Grenada it receives a large tributary from the right and north side called Schooner River, and immediately above the town another large tributary, called Bogue Creek, comes in from the left side. Between Grenada and the mouth there are several small tributaries, nearly all on the right and north side. Before leaving Grenada I made inquiries from prominent citizens both as to the navigation of the river and the trade and resources of the adjacent country.

During the winter of 1878-79 three boats of from 600 to 800 bales (of cotton) capacity reached Grenada, one boat making three trips, or, in all, five to six trips, which, at 600 bales per trip, gives from 3,000 to 3,600 bales carried from this region last year by steamboats. The total amount of cotton then shipped from Grenada was 12,000 bales, and, had the boating facilities been sufficient, fully one-half would have been shipped by boat. The boats also bring up supplies (provisions, etc.)

Prior to the late war boats of 1,200 to 1,500 bales capacity reached Grenada, which place has generally been considered the head of steamboat navigation. Keel boats

carrying 300 to 400 bales have run as far up as Graysport, 12 miles above. The railroad bridge crossing the river at Grenada is a bar to navigation above.

The country through which this river runs is sparsely settled near its banks; in most places the land is subject to annual overflow, in part caused by backwater from the Yazoo River. The overflowed district extends from one-half to 1 mile inland, where hill or rolling country is reached, much of which is settled, producing principally cotton.

At about 30 or 35 miles below Grenada the hill country ends, and from thence to its mouth the river flows through a flat bottom country for 60 miles, nearly all of which is overflowed almost annually for miles back from the river.

Along the entire portion of the river examined I counted 10 clearings and six or seven steamboat landings. As the river was reported to be about 4 feet above low water when I left Grenada, I was not able to determine the obstructions in the channel with as much accuracy as I would wish. During my trip down, the river was slowly rising. The rise at Greenwood on Yazoo River was reported to me as 5 feet above low water on December 8.

I learned from several sources that in extreme low water numerous snags are shown, making the river in many places impassable to a skiff. With the river 4 feet above low water I counted 150 snags in the channel, besides ten or twelve rack heaps (three or four of the largest being about 25 by 50 yards and occupying about half the width of the river). A considerable number of the projecting snags appeared to be branches of trees which had fallen in the channel. Many can be readily removed by cutting up during low water.

For about 40 miles below Grenada the banks have been cleared of overhanging trees. This work was done during the past summer at an expense of $600, paid by the county of Grenada.

Four years ago the Grangers' Society expended several hundred dollars on similar work. Much of the timber and brush cut last summer is lodged in the river, the greater part of which will, I think, go off during high water.

On the lower 55 or 60 miles there is considerable overhanging timber, forming obstructions to navigation; they are oak, willow, sycamore, and some few cypress, mostly of medium size. Both banks of the river from Grenada to the mouth are covered with timber; the greater portion of that suitable for lumber is oak, of which there is a large quantity. At a few places, where the bluffs reach the river, pine is seen. Near the mouth is some cypress.

The width of the river at the present stage of water is from 40 to 60 yards; in a few places, nearer the mouth, reaching 70 to 80 yards.

The banks to a height of 10 or 12 feet are in general steep, caving but in few places. Owing to the rapidity with which the water falls at times, boats risk running to Grenada only during high water (6 to 10 feet above low water). At the present stage (4 feet) there is a good current. I estimate the velocity in the channel at from 2 to 3 feet per second, or 1½ to 2 miles per hour. The country passed through is alluvial, with more sand in the upper part, producing from one-half bale of cotton in the uplands to one bale per acre on the bottoms.

A part of the hill lands is much broken by ravines and gullies, caused by the rain waters, thus making a considerable portion unfit for profitable cultivation. Much of the hill lands are said to be very inferior cotton lands.

The freight rates on cotton from Grenada to New Orleans are, via railroad, $3.50 per bale; via steamboat last winter, $2.50 per bale, and when improvements are made in the river the steamboat lines agree to carry cotton to New Orleans for $2 per bale; the latter is the present price from Greenwood on the Yazoo.

In conclusion, from lack of definite knowledge concerning the river during low water, I do not feel justified to recommend its improvement for permanent navigation. Still, I am of the opinion that a small sum can be profitably expended to remove such obstructions as will insure the safe passage of boats during at least four months of the year, which time the water is said to be 3 or 4 feet above extreme low water; such improvements to consist in the cutting of overhanging trees and the removal of rack heaps and the most prominent snags, thereby insuring navigation to small boats. I therefore recommend, as the amount that can be profitably expended, the sum of $7,000.

Very respectfully, your obedient servant,

W. MARSHALL REES,
Assistant Engineer.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

Under river and harbor act of August 2, 1882, a further examination of the stream above Grenada was made by Captain Miller, who reported as follows:

The Yallabusha River above Grenada, Miss., is a very narrow, tortuous, shallow, and much obstructed stream. It requires the waters from the Loosacoona, in addi-

tion, to render the Yallabusha River worthy of improvement below Grenada. The bed of the stream is a mass of logs and drift, with frequent sand bars, with also a great amount of timber obstructing the stream. The only business done on the river is flatboating firewood.

* * * * * * * *

I do not consider a survey of the river necessary, and, in view of the facts as above reported, in my judgment the river is not worthy of improvement, nor the work a public necessity. (Report Chief of Engineers, 1884, p. 1342.)

Appropriations for improving the river were made by the following river and harbor acts:

March 3, 1881	$3,500
August 2, 1882	3,500
July 5, 1884	2,000
August 5, 1886	2,000
Total	11,000

These amounts were applied to the removal of obstructions to navigation from Grenada to the mouth, in accordance with the project submitted by Major Benyaurd in 1879. In June, 1881, a flatboat was built at Grenada for use on the work, and during the succeeding three months operations of a chopping party were carried downstream to the mouth, removing the worst obstructions, so as to permit navigation at high stages. With the second appropriation work was resumed at the mouth September 1, 1882, and between that date and December 7, 1882, it was carried upstream to within 30 miles of Grenada, greatly improving navigation. Major Benyaurd estimated that $7,000 would be required to cut leaning timber, remove rack heaps and the most dangerous snags, to afford safe passage for small boats for about four months of the year. This amount was appropriated by the acts of 1881 and 1882, but at the close of the fiscal year 1883 Major Miller reported:

Although the amount of the original estimate for the improvement of this stream, $7,000, has been appropriated and nearly all expended, owing to the nature of the stream continual changes are taking place, which require constant work in the way of snagging and removing fallen timber, and for this purpose $3,500 is asked, to be expended during the fiscal year.

This recommendation was repeated in his report of 1884, but as the river and harbor act of that year appropriated only $2,000, the estimate was increased to $5,000.

October 1 to December 22, 1884, work was continued under the appropriation of July 5, 1884, and operations of a chopping party were carried from Grenada downstream to the mouth, special attention having been given to removal of obstructions in the upper portion of this stretch. With the last appropriation, by act of 1886, the U. S. snagboat *John R. Meigs* was employed March 17 to April 10, 1887, in removing obstructions from the lower river, operations having extended from the mouth about halfway to Grenada.

In my annual report for 1887 I recommended that the sum of $6,000 be appropriated for expenditure in one season of low water in order that the stream might be worked over from Grenada to its mouth so thoroughly that only small amounts would be needed from time to time to remove snags and drift brought down by floods or fallen timber and stumps caused by caving banks. The river and harbor bill as reported by the committee March 31, 1888 (H. R. 9050, Fiftieth Congress, first session), contained an appropriation of $3,000 for continuing improvement of Yallabusha River, but this appropriation was struck out before the bill finally became a law August 11, 1888, and by letter of the Chief

of Engineers, dated August 7, 1888, I was directed to omit the work from my annual report and list of duties, and to return any balance of funds in my hands to the Treasury to the credit of the appropriation.

Notwithstanding the work done in 1881, 1882, 1884, and 1887 for the improvement of navigation, there was no resulting increase of commerce. On the contrary, the business dwindled until boats discontinued trips at any stage, as shown by the following extracts from reports of the Chief of Engineers.

Grenada is the principal shipping point, from which place annually the amount of cotton shipped is estimated at 12,000 bales. The greater portion of this finds its way by rail to New Orleans. The shipment by river last season amounted to 3,000 to 3,600 bales. (1880, p. 1349; 1881, p. 1415.)

It is estimated that about 12,000 bales of cotton are raised along the Yallabusha, about 5,000 of which goes by boat to Vicksburg, the balance being taken to the railroad. (1882, p. 1555.)

It is estimated that from 12,000 to 15,000 bales of cotton are produced along this stream. Of this amount but 3,000 goes by boat to Vicksburg, the balance being taken to the railroad. (1883, p. 1153; 1884, p. 1337.)

Grenada, the head of navigation, is the principal distributing point for this stream. The following are the commercial statistics of Grenada, according to an average of the last three years' shipments: 18,000 bales of cotton, valued at $900,000; estimated value of other freights, $600,000. The principal portion of this, however, is shipped by rail. * * *

During the winter and spring of 1884–85 a small steamboat made regular trips from Greenwood, on the Yazoo, to Grenada, carrying up cotton and cotton seed and return freights of plantation supplies, etc. During the past year the Grenada Oil and Compress Company received by river 5,000 tons cotton seed, valued at $70,000; other freights valued at $5,000. (1885, p. 1522.)

The river was navigable from Grenada to the mouth about six months of the fiscal year. No steamboats navigated the stream within this time. (1886, p. 1363.)

No steamboats ply in this stream at present, and the commerce amounts to little or nothing, but steamboat men say that the trade will begin if the river be cleared to Grenada. * * * There is depth enough for boats in high water, but leaning timber prevents passage at such times. (1887, p. 1474; 1888, p. 1362.)

Statements of commerce necessarily were crude and uncertain. No regular steamboats ran into the Yallabusha, and those that made occasional trips from the Yazoo kept no separate records, hence the business could only be estimated approximately, and it was difficult to obtain any information upon the subject.

The improvement of Yallabusha River above Grenada is impracticable, as shown by Major Miller's report of 1884. Below Grenada to its mouth, a distance variously estimated at 63 to 90 miles, it is capable of improvement by the removal of leaning timber, snags, etc., so as to be navigable for a limited portion of each year, or during high stages. Owing to the rapidity of the fall at times, boats could not risk a trip to Grenada unless there was reasonable assurance of continued high water. From Grenada to Tuskahoma Ferry, about one-third the distance to the mouth, the river runs through a hilly country, but below the latter place its course is through a flat bottom or swamp, subject to overflow for miles back, and with few places where a steamboat could make a landing at high stages. There is no town or village of any importance on the river below Grenada, and the country along the banks is sparsely settled, the necessity for mail service being supplied by three post-offices, Le Flore and Peete on the upper end of the Yazoo branch of the Illinois Central Railroad, and Oxberry on the opposite side of the river, the latter having mails three times a week from the railroad and all three offices being less than 4 miles apart and near the railroad terminus.

The Mississippi and Louisiana and the Memphis divisions of the Illinois Central Railroad join at Grenada, and the main line continues

about 12 or 13 miles long. Old River outlet is at the upper end of the lake, is about 8 miles long, flows in an easterly course, and joins French Fork about 15 miles from the mouth of the stream at Trinity, La. From the junction of Old River and French Fork the stream flows in a nearly easterly course, and unites with the Ouachita and Tensas rivers at Trinity in forming Black River.

Little River above Catahoula Lake forms the boundary line between Grant and Catahoula parishes; after leaving the lake its course lies entirely within Catahoula Parish, and its entire length by the French Fork route (which is the only one traveled by boats crossing the lake) is about 115 miles, counting 7 miles distance across the lake.

From the head of the river down to Hawthorn Camp, a distance of about 20 miles, the stream is narrow and crooked, and the channel is badly obstructed with sunken saw logs and a few caved-in trees. From Hawthorn Camp down to Catahoula Lake it is 350 to 400 feet wide, has firm banks, and the only obstructions are a few sunken logs lost from rafts while being floated down the river. The distance from Hawthorn Camp to the lake is about 60 miles and no improvement whatever is required in that portion of the stream. Between Hawthorn and the head of the river I found 5 feet of water; between Hawthorn and Catahoula Lake I did not find less than 12 feet. Crossing Catahoula Lake, the greatest depth of water found was 4½ feet and the least depth 3½ feet. Below Catahoula Lake the stage of water was too high to note obstructions on the bottom. The Ouachita gauge at Jonesville read 22 feet, rising, when I arrived there.

In regard to the improvement of the upper portion of Little River, I have to say that the only interest to be served is that of a few men engaged in getting out timber and staves. While the clearing of the channel of snags would make it less difficult for them to float timber and staves out, I can not see that the improvement would be of any benefit to the community at large. Even the timber men acknowledge that theirs is the only interest at stake. The bridge watchman at head of Little River informed me that the bridge had never been opened for a boat to pass through since it was built in 1891.

The only resources of the country are its timber, and there is no probability that others would be opened up by improvement of the stream. As the timber men are the only ones to be benefited by improvement, it seems to me that the cost should be borne by them, and not by the General Government. If they would get together and clean out the river, the expense to each would be very little, for the reason that they could pick up enough sunken saw logs from the channel of the river to pay them for their trouble.

There is a sawmill at Little River Station not running, and one 16 miles below that is running. These mills ship their lumber by rail, but get their logs by river. The improvement of the stream would be no inducement for them to ship by water on account of the uncertainty of crossing Catahoula Lake. The Houston, Central Arkansas and Northern Railroad (a branch of the Missouri Pacific system) runs within a few miles of the west bank of the stream, and is the means of transportation for supplies and products as far down as Catahoula Lake, which, I was informed, is only 10 miles from the railroad. Steamboats only ply the upper portion of Little River as high as Wadly Landing, near White Sulphur Springs, and about 40 miles above the lake. Wadly Landing is the shipping point for the surrounding country on the east bank of the stream, and ships 300 to 400 bales of cotton yearly. One and one-half miles below Wadly is Thompson Landing, and 4 miles below that is Kittrel Landing. The two last-named are shipping points for the adjacent country on the west bank, and ship about the same amount of cotton and seed as Wadly. At any stage of water that a boat can cross Catahoula Lake it can go to these landings, for the bottom of the lake appears to be 5 or 6 feet higher than the bottom of the river.

For the reasons stated above, I can see no necessity for an appropriation by the General Government for the improvement of Little River above Catahoula Lake. Below Catahoula Lake rich, fertile plantations border the stream, which is the only means of transportation for their products and supplies. As the river was too high for personal verification of Captain Knight's report of obstructions in that portion of the stream, I made inquiry of planters living along its banks, and they confirmed his report in nearly every particular.

When the former appropriation of $2,500 was expended the stage was too high for removal of all obstructions from the bottom of the river. Stumps, snags, and logs on the bottom are obstructions that require removal now. I have no doubt that their removal would be beneficial to the community along the stream, in that it would permit steamboats to run at a lower stage, to make quicker trips, and save the planters a long haul by wagons.

Whether the stream could be made navigable for a small boat at all seasons of the year can only be determined by a survey at an extreme low stage, by taking soundings, and noting class of obstructions at shoal places. There is no leaning timber to be cut, and nothing but channel improvement required. * * *

The work should be done by a small party, using explosives extensively, and at a very low stage. If well done at a low stage, the improvement would be nearly permanent, for the only obstructions liable to form afterward would be an occasional saw log lost from a raft while floated down the stream. The wrecks referred to by Captain Knight are very near the mouth, and can be removed easily with explosives at a low stage of water.

I was only able to find one man from whom I could get information as to the amount of commerce carried down this stream. I overtook Mr. J. T. Hawkins going down the river with a barge of staves, and he informed me that he had 40,000 staves ready for the market, but on account of low water had not been able to get them out. He gave me the names of six others employed in the timber business, and estimates that they get out annually 150,000 staves and 100,000 saw logs, and that the commercial value of these articles is about $322,500.

Respectfully submitted.

WATKINS DECKER,
Master U. S. Snag Boat Wagner.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

In the fiscal year ending June 30, 1895, navigation to White Sulphur Springs opened January 10 and closed April 1. From September 1 to January 10 freights were carried in small barges from Rhinehart's Ferry to the mouth, about 25 miles.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Laura Blanks	Stern-wheel.	62.73	104.8	21.3	3.8	0 18	3 6	Trinity and White Sulphur Springs.	30	100
Marcus Collins	do	48.14	90.0	17.0	2.5	13	2 6	do	25	30
Albert Lea	Side wheel.	24.47	64.8	12.3	4.0	2 6	4 0	Not reported	....	....

The following is a summary of the commerce reported:

	Tons.
Cotton	750
Cotton seed	500
Hides and skins	5
Lumber	10
Staves	2,475
Provisions	110
Grain	250
Miscellaneous	75
Saw logs, rafted (on account of low stages all not brought out)	150,000
Total	154,175
Estimated value, in round numbers	$570,000

Little River from its head to Catahoula Lake I do not consider worthy of improvement, as boats from below can not reach it, except at stages high enough to cross the lake, when it has ample width and depth for the needs of its commerce. For the reasons stated in Assistant Decker's report, and in view of the commerce reported, it is my opinion that Little River from Catahoula Lake to Trinity, La., including the French Fork, is worthy of improvement by the General Government, to the extent of removing the chief obstructions in the channel and destroying the wrecks at the mouth. This work should be done at a low stage by hired labor, high explosives being used freely for destroying the wrecks and large snags and logs. The funds should be provided in a

single appropriation, so that operations may be completed in one season of low water. The leaning timber was cut when the former work was done. The greater portion of the drift from the upper branch will be scattered in the lake, and the work will be of a more permanent character than the majority of those in this district, which require repeated snagging operations from time to time. A survey is not necessary.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. Henry M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, July 30, 1895.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion that Little River, above Catahoula Lake, is not worthy of improvement by the United States, but that Little River between Catahoula Lake and its junction with the Black River, a distance of about 28 miles, is worthy of improvement by the United States to the extent of removing the chief obstructions in the channel and destroying the wrecks at its mouth. The officer in charge reports that no survey is necessary to the preparation of project and estimated cost of improvement proposed.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

U 25.

PRELIMINARY EXAMINATION OF BOGUE PHALIA, MISSISSIPPI, ESPECIALLY AT THE POINT KNOWN AS "THE NARROWS."

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., August 22, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Bogue Phalia, Mississippi, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894.

This stream, about 115 miles in length, is a tributary of Big Sunflower River, and its course lies within the counties of Bolivar and Washington, Miss. It is crossed near Elizabeth by a branch of the Southern (formerly the Georgia Pacific) Railway, its course is paralleled by the Yazoo and Mississippi Valley (formerly Louisville, New Orleans and Texas) Railroad, and it is considered an unnavigable stream.

To comply with the requirements of river and harbor act of August 11, 1888, an examination of Bogue Phalia was made under my direction in December, 1888, by Assistant Engineer H. M. Marshall; report thereon was submitted February 12, 1889 (Report Chief of Engineers, 1889, pp. 1628–1629), and Assistant Engineer Marshall's report is repeated in full below:

This bayou, having its source in three prongs, which begin in the north edge of Bolivar County, Miss., just south of the ridge which forms the watershed between

this bayou and Hushpuckena, flows south into Washington County, and in the southern part of the county turns east, emptying into Sunflower River. From the juncture of the prongs to the head of the narrows, a distance variously estimated from 35 to 50 miles, the bayou is virtually a lake 200 feet wide and 20 feet deep at low water. The banks are low, but seldom overflow, except from breaks in the Mississippi River levees, the oscillation from rain being about 8 feet. At the head of the narrows there is a raft or jam 300 feet long, and one 2 miles below 100 feet long, and one 200 feet long 1 mile still lower down. From the head of the narrows to the mouth of Clear Creek the distance is 20 miles, and the bayou is from 40 to 75 feet wide and from 1 foot to 6 feet deep. The channel is very crooked, filled with logs and drift jams, divided in three places by small towheads, besides a chute leaves the bayou a mile below the head of the narrows and returns about 3 miles above the mouth of Clear Creek. The banks are very low, composed of clay, and subject to overflow. From the mouth of Clear Creek to the mouth of Bogue Phalia is 60 miles, and along the upper 45 miles the bayou is wide and deep, but narrow, swift, and shallow along the lower 15 miles, where it is crooked and divided by small towheads. The banks are high and sandy, being above overflow, but subject to caving where cleared of timber. Above the narrows there is a large amount of cleared land, though a good deal that was formerly in cultivation was abandoned during the overflow in 1882, and is just now being reclaimed. It is estimated that there are 4,000 bales of cotton raised annually in this section and now hauled to landings on the Mississippi River or stations on the Louisville, New Orleans and Texas Railroad, the haul being from 5 to 20 miles. The country adjacent to the narrows is unimproved, being nothing but swamps and canebrake. Below the narrows the land is being rapidly opened. Of the 75 or 100 cabins on the banks, scarcely one is a year old. The country is being developed almost entirely by negroes. One said he could scarcely make a living in the hills, while in two years since he moved he had cleared 150 acres of land and bought and paid for a wagon and four mules. The Louisville, New Orleans and Texas Railroad crosses the bayou 10 miles below the narrows and gradually diverges to the northeast and southwest. The distance from the railroad to the bayou is, at Cleveland, 15 miles; Shaw, 5 miles; Helm, 1 mile; Leland, 6 miles; Burdette, 4 miles; Arcola, 2 miles. From Shaw to Arcola is 25 miles by the railroad, and from a point on Bogue Phalia opposite Arcola to a point opposite Shaw is 60 miles by the bayou, leaving 20 miles of the lower end and 40 miles of the upper that is not adjacent to the railroad. It is but fair to say, however, that the roads to the railroad become impassable after rains. A wagon which had started from the bayou one Saturday with a load of cotton, being overtaken by a heavy rain, had not reached Shaw, 5 miles away, the following Wednesday, though the driver labored daily. The Georgia Pacific Railroad crosses the bayou 4 miles below the Louisville, New Orleans and Texas crossing. The bridges on both roads are frame trestles, with bents 12½ feet apart. The authorities of Washington County are constructing a pile bridge across the bayou opposite Arcola. A small steam trading boat and a boat with a gin on board ply above the narrows, but they are the only ones running on the bayou. Previous to the building of the Louisville, New Orleans and Texas Railroad and Georgia Pacific Railroad branch down Deer Creek, boats went up Bogue Phalia to bring down cotton hauled over from Deer Creek and to take up supplies to the planters. There is now no commerce on Bogue Phalia, and no record of former commerce is obtainable; but, without doubt, ten years hence there will be at least 25,000 bales of cotton, worth $750,000, produced annually on its banks. Below the narrows all leaning trees, snags, and logs could be removed for $100 a mile, or $6,000. It would cost each railroad $10,000 to change their bridges to let boats through, and Washington County nearly as much for its bridge. Through the narrows it would cost $250 a mile to clear the banks and remove the logs, jams, and snags, or $5,000 for the reach. Very small boats could, with some trouble getting round the bends, then ply from the time autumn rains begin till late in the spring. Very little is needed above the narrows, and $1,000 would clear it all. To improve the narrows so as to allow boats 100 feet in length, drawing 3 feet water, to run, would require the bayou to be widened and straightened, which would take a deal of dredging, for which no estimate of cost can be made without a survey.

The improvement of Big Sunflower River was undertaken by the United States in 1879, to carry out a project submitted by Captain (now Lieutenant-Colonel) Benyaurd for the removal of snags, sunken logs, and leaning timber obstructing navigation and building wing dams to scour a channel about 40 inches deep at the shoals. The cost of the work then needed was estimated at $66,000, with the expectation of completing it in not more than three to four consecutive seasons; small appropriations to be made from time to time thereafter for maintenance. The total amount appropriated from 1879 to the present time, a period

of sixteen and one-half years, is $67,000. The first appropriation of $20,000 was followed by successive annual appropriations of $8,000, $4,000, and $5,000, and fairly good results were attained. Since 1882 biennial appropriations of $5,000 each have been made, but, as new obstructions are adding continually, they scarcely have been sufficient to maintain what was accomplished by the early work.

It is my opinion that Bogue Phalia is not worthy of improvement by the General Government, at least at the present time, and, until Big Sunflower River is put in safe navigable condition, it would be unwise and a waste of funds to undertake an extension of its improvement into tributary creeks.

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. Henry M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION.
New York, August 27, 1895.

Respectfully forwarded to the Chief of Engineers, United States Army.

As the Bogue Phalia is a tributary of the Big Sunflower River, which latter river the General Government has not seen fit to put in a safe navigable condition, only appropriating for the last thirteen years sufficient to maintain the partial improvement previously made, therefore I concur in the opinion of Major Willard that the Bogue Phalia is not worthy of improvement by the General Government, at least until the Big Sunflower River has been put in a safe navigable condition.

HENRY M. ROBERT,
Colonel of Engineers, Engineer Southwest Division.

U 26.

PRELIMINARY EXAMINATION OF BEAR CREEK, MISSISSIPPI, FROM WHERE IT EMPTIES INTO THE YAZOO, UPSTREAM.

UNITED STATES ENGINEER OFFICE,
Vicksbury, Miss., August 22, 1895.

GENERAL: In compliance with instructions contained in letter from your office dated August 20, 1894, I have the honor to submit the following report respecting Bear Creek, Mississippi, a preliminary examination of which was called for by section 10 of river and harbor act of August 17, 1894.

The stream known as Bear Creek is a succession of small lakes and creeks near the intersection of Leflore, Sunflower, and Washington counties, Miss. It has its source in Mosquito Lake, about a mile south of Itta Bena, on the Atlanta, Ga., and Greenville, Miss., line of the Southern Railway, and about 5 miles west of Yazoo River. Following the general course of the Yazoo, at distances varying from 1 to 10 miles, it enters it through Wasp Lake, at Wasp Lake Landing, on the

river side of Honey Island. A straight line from head to mouth is a distance of only 20 miles, but, owing to the irregular course traversed, its length is estimated to be between 80 and 90 miles. It is navigable when flooded by backwater from the Yazoo, at moderately high stages of the latter in the winter and spring, but during the period of low water the connecting creeks run dry and the lakes become stagnant ponds.

Under section 3 of river and harbor act of March 3, 1881, an examination of this stream was made during autumn of that year by Major Benyaurd. The law directed "examinations or surveys, or both, and estimates of cost of improvements." No opinion was called for as to the public necessity or convenience to be subserved by the proposed improvement, or whether the stream was considered worthy of improvement by the United States, and Major Benyaurd reported as follows:

The improvement of Bear Creek would consist simply in cutting out sufficient timber, etc., to give a good high-water channel for such small steamers as might navigate the stream. The estimated length of such a channel through the creek proper and lakes is 44 miles; and the estimated cost of the work is placed at $6,000. (Report Chief of Engineers, 1882, p. 1563.)

The yearly commerce of the stream at that time was reported to consist of about 1,000 bales of cotton, 500 tons cotton seed, 90,000 staves, and 400,000 feet lumber; estimated value of all, $71,600.

No action was taken on this report, and it is presumed the river and harbor committee did not deem the creek worthy of improvement.

Section 6 of river and harbor act of August 5, 1886, directed that an examination or survey of Bear Creek, Mississippi, be made, and the preliminary examination was assigned to me by letter of the Chief of Engineers, dated September 27, 1886. In February, 1887, it was learned at the Department that the stream for which provision for examination or survey was made was Big Bear Creek, a tributary of Tennessee River, in the States of Alabama and Mississippi, and by letter of the Chief of Engineers dated February 21, 1887, I was directed to transfer charge of same to Lieutenant-Colonel Barlow.

In the meantime, January 22–26, 1887, an examination of the Bear Creek tributary to Yazoo River had been made under my direction by M. B. Lydon, now master of the U. S. snag boat *Howell*, whose report is given below:

VICKSBURG, MISS., *February 24, 1887.*

CAPTAIN: In compliance with your orders of 14th ultimo, on completion of examination of Cassity Bayou, January 21, I took steamer to Sheppardtown; from there went horseback to Bear Creek, and was engaged upon an examination of the latter stream the succeeding five days.

Bear Creek is a succession of ponds, known as Wasp, Four Mile, Six Mile, Three Mile, and One Mile lakes. Wasp Lake is 8 miles long, from 400 to 500 feet wide, and 10 to 12 feet deep at low water. It is connected with Four Mile Lake by a narrow bed 8 miles long, and dry at low stages. Four Mile Lake has about the same width as Wasp Lake, is free of obstructions, has a good supply of water, and is connected with Six Mile Lake by a narrow winding depression, about 2 miles in length, densely covered with undergrowth and cypress knees, being similar in every respect to the connection between Wasp and Four Mile lakes. Six Mile Lake is not obstructed, and its general characteristics correspond with Wasp and Four Mile lakes.

The examination from Yazoo River, at the mouth of Wasp Lake, up to head of Six Mile Lake, which I consider the practical head of navigation, was made in a dugout. The distance is 28 miles. Above the latter point the examination was continued, partly afoot and partly horseback. Three and One Mile lakes and their connections are merely depressions in the swamp, and all of them are heavily timbered.

When the Yazoo River at mouth of Wasp Lake reaches a stage above 11 feet the connections between the lakes are overflowed by backwater, affording a navigable depth for small steamers for a period of about five months of the year, during the winter and spring, and, in my opinion, any feasible plan for the improvement of navi-

gation would consist of cutting and girdling trees and clearing and grubbing the undergrowth from the channels between Wasp and Four Mile Lakes and the latter and Six Mile Lake, a total distance of 10 miles, to give a clear passageway 125 feet in width. This work probably would cost about $2,000.

As near as I could ascertain, the annual commerce of the locality was about the same as reported by Major Benyaurd in 1881, viz: 1,050 bales cotton, 500 tons cotton seed, and 90,000 oak staves. The vicinity of and easy approach to landings on Yazoo River, however, have diverted most of the trade to that stream. During the cotton-shipping season low water generally prevails in Bear Creek, and when high water sets in nearly all the cotton has been hauled to Yazoo River, hence the profit arising from navigation of the creek must be nominal.

Respectfully submitted.

M. B. LYDON.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

Within the last year repeated efforts have been made to ascertain the present and prospective commerce of Bear Creek, but the following correspondence with the superintendent of the Yazoo and Tallahatchie Transportation Company contains all I have been able to obtain upon the subject:

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 22, 1895.

Mr. C. M. KAIN,
Superintendent Yazoo and Tallahatchie Transportation Co., Vicksburg, Miss.

DEAR SIR: The river and harbor act of August 17, 1894, provides for a preliminary examination of "Bear Creek, Mississippi, from where it empties into the Yazoo upstream," which was assigned to my charge by the Chief of Engineers, U. S. Army, with instructions that my report thereon "should state, as required in section 11 of the act, whether, in your opinion, the river is worthy of improvement by the General Government, and give fully and particularly the facts and reasons on which you base such opinions, including the present and prospective demands of commerce."

As it is probable that, if there is any navigation of Bear Creek at present, it is carried on by the boats of your line, I shall be obliged if you will give me, at your earliest convenience, accurate information upon the subject, as full as possible, and especially respecting the following points, viz:

(1) If Bear Creek is navigable, at what stages can boats enter the mouth, and how far upstream do they run?

(2) What boats ran into the creek the last twelve months; what are their dimensions; how many trips did each boat make, and to what points?

(3) What is the present average annual commerce of the creek, giving amounts of staple articles of freight (cotton, seed, general merchandise, etc.), in tons, and what is its estimated value?

(4) What form of improvement is desired by steamboat men, and what would be its probable effect in increasing the period and limit of navigation and commerce of the stream?

Very respectfully,

J. H. WILLARD,
Captain, Corps of Engineers.

YAZOO AND TALLAHATCHIE TRANSPORTATION CO.,
Vicksburg, Miss., August 15, 1895.

Capt. J. H. WILLARD.

DEAR SIR: Bear Creek is navigable about eight months in the year for 50 miles.

Steamer *Hendricks* made 1 trip; *Bailey* made 20 trips; *Yazonia* made 15 trips; *Des Arc* made 6 trips.

(For dimensions see List of Merchant Vessels of United States.)

Product of cotton, etc., from this about—

Articles.	Quantity.	Tons.	Value.
Cotton.....bales..	600	150	$21,000
Cotton seed.....sacks..	1,000	200	1,600
Staves..	200,000	500	28,000
Cattle.....head..	500	75	4,000
Hides	.....	20	280
Total	.....	945	54,880

Improvement needed: Taking from river stumps and snags, and cutting the leaning trees. Country is being rapidly opened up, and were the river cleaned up product would be considerably increased.

Respectfully, CHAS. M. KAIN, *Superintendent.*

In view of the information contained herein, it is my opinion that there is no public necessity or convenience to be subserved by the improvement of Bear Creek, and that it is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. Henry M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, August 27, 1895.

Respectfully forwarded to the Chief of Engineers, United States Army.

For the reasons stated by Major Willard, I concur with him in the opinion that Bear Creek, Mississippi, is not worthy of improvement by the General Government.

HENRY M. ROBERT,
Colonel of Engineers, Engineer Southwest Division.

APPENDIX V.

IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT OF LIEUT. WILLIAM L. SIBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing obstructions in Arkansas River, Arkansas and Kansas.
2. Arkansas River, Arkansas.
3. Fourche Le Fevre River, Arkansas.
4. Petit Jean River, Arkansas.
5. White River, Arkansas.
6. Cache River, Arkansas.
7. Black River, Arkansas and Missouri.
8. Current River, Arkansas and Missouri.
9. St. Francis River, Arkansas.
10. St. Francis River, Missouri.
11. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS.

12. Cache River to Riverside, Ark.
13. St. Francis River, from the Sunk Lands to Greenville, Mo.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 9, 1895.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year 1895 of the following works of river and harbor improvement under my charge.

* * * * * * *

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieutenant of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

V 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS AND KANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

Object.—To remove (otherwise than by permanent works) obstructions to navigation.

Project.—Originally to raise and destroy snags, cut overhanging timber, remove bowlders and reefs by blasting and dredging, and to cut out sand bars by temporary wing dams. The survey of the river with a view to project for permanent improvement was included under this head.

Since appropriations for permanent improvement were made blasting, dredging, and dams have been omitted from the project under this head, leaving the customary snagging operations only.

OPERATIONS OF PREVIOUS YEARS.

The first snagging operations were under the act of July 3, 1832. The work began about August, 1833, and February 18, 1834, is said to be the date of arrival of the first snag boat, *Archimedes*, at Little Rock. Of the work done prior to 1868 I am unable to give any information.

Abstract of work done 1868 to 1894, inclusive.

Fiscal year.	Snags removed.	Trees cut.	Trees deadened.	Drift piles removed.	Between—
1868	134	.....	.....	.....	Mouth and Douglas Landing.
1869	50	1	.....	.....	(?)
1870	805	114	.....	.....	(?)
1871	1,169	5,925	.....	.....	Mouth and Illinois Bayou.
1872	542	257	.....	2	Mouth and Pine Bluff.
1873	110	44	.....	.....	Little Rock and Bentleys Bar.
1875	663	1,570	.....	23	Mouth and Fairdale.
1876	545	1,274	.....	5	Mouth and (?)
1877	193	234	.....	3	Mouth and Silver Lake.
1878	430	1,177	.....	11	Mouth and Little Rock.
1880	750	488	.....	19	Mouth and Trustee Bend.
1881	391	346	.....	23	Little Rock and Webbers Falls.
1882	976	3,460	.....	18	Mouth and Fort Smith.
1883	1,287	786	.....	8	Do.
1884	1,118	1,135	.....	8	Mouth and Fort Gibson.
1885	2,244	14,325	17	20	Mouth and near Pawnee Agency.
1886	109	14	.....	2	Mouth and Little Rock.
1887	1,385	143	.....	.....	Mouth and Fort Smith.
1890	552	231	.....	.....	Little Rock and Webbers Falls.
1891	300	2,000	13,000	.....	Little Rock and mouth.
1892	787	544	.....	4	Mouth and Webbers Falls.
1893	862	670	.....	17	Pine Bluff and Dardanelle.
1894	387	1,346	.....	1	Little Rock and Hog Thief Bend.

During the time covered by the above abstract three snag boats have sunk while in service, the *Northwest* at Stanleys in fiscal year 1868, the *Thayer* at Bentleys Bar in fiscal year 1873, and the *Pioneer* at Hughes Bend in fiscal year 1893.

The records of the *Northwest* were lost when the boat sunk, hence her work is not included in that of 1868.

OPERATIONS OF THIS FISCAL YEAR.

The U. S. snag boat *Beauregard* was operated from September 27, 1894, to January 8, 1895, between the foot of White River Cut-Off and Homestead, 30.6 miles; the U. S. snag boat *Sheldon* during a part of October, 1894, between Ives Point and Grape Leaf Bend, 45 miles, and a part of November, 1894, between Caldwells and Pine Bluff, 25 miles; and the snag boat *Wichita* during January and part of February, 1895, between Mud Lake and Old River, 85 miles, doing no work between Wild Cat and Red Bluff.

Abstract of work done.

Month.	Snag boat.	Between—	Snags removed.	Trees cut.	Drifts removed.
Oct., 1894	Beauregard	Foot of cut-off and Red Fork	150	7	1
Do	Sheldon	Ives Place and Grape Leaf Bend	139	24	.....
Nov., 1894	Beauregard	Foot of cut-off and Red Fork	211	195	5
Do	Sheldon	Caldwells and Pine Bluff	82	648	.....
Dec., 1894	Beauregard	Waddell and Arkansas Post	229	445	9
Jan., 1895	do	Arkansas Post and Homestead	113	236	3
Do	Wichita	Mud Lake and Bankhead	202	1,016	1
Feb., 1895	do	Mosby Lake and Olive Gin. / Red Bluff and Old River	28	31	.....
Total			1,154	2,602	19

The operations of the snag boat *Wichita* above Fort Smith are reported under the head "Improvement of Arkansas River."

The Arkansas River has in the State of Arkansas about 370 miles of caving banks; most of the bars are built upon, and many of the channel crossings are over rack heaps. The caving banks make continual contributions of snags; the wearing away of sand bars brings the older accumulations into the channel, and removing the snags from the crossings allows the sand to wash and expose others.

All of these go to make snagging operations a continuous necessity.

The evidence of pilots and masters is that in the permanent reaches of the river the condition has been materially improved; in the shifting channels the relief is only temporary.

In the lower reaches of the Arkansas River its current is checked by the floods of the Mississippi; the snags and logs drifting toward that stream are deposited in the bed of the Arkansas in all conceivable shapes. In the absence of current the snags make no "breaks"; consequently the dangers to navigation are greatly increased.

Snagging operations will be necessary as long as there is a caving timbered bank and a shifting channel; they should not be diminished for many years, and could profitably be increased.

APPROPRIATIONS AND EXPENDITURES.

Appropriations for operating snag boats on the Arkansas River have been made intermittently since 1832. Many of the early appropriations were combined with those of other rivers without stated distribution of funds. The estimate of expenditures is not given as absolute but as a close approximation.

July 3, 1832 (less $38 carried to surplus fund)	$14,962.00
March 3, 1835	40,000.00
March 3, 1837	25,000.00
July 7, 1838 (less $1,115.66 carried to surplus fund)	38,884.34
From appropriations 1842–1844 (estimate)	80,000.00
August 30, 1852 (less $269.47 carried to surplus fund)	39,730.53
From appropriations 1866–1878 (disbursements reported by Colonel Suter)	344,831.59
March 3, 1879 (part)	30,000.00
June 14, 1880 (part)	35,000.00
March 3, 1881 (part)	25,000.00
August 2, 1882	35,000.00
July 5, 1884	36,000.00
August 5, 1886	19,875.00
August 11, 1888	25,000.00
September 19, 1890	20,000.00
From sale of Reese	20,000.00
July 13, 1892	20,000.00
From sale of Missouri	2,500.00
August 17, 1894	20,000.00
Total	871,783.46
Expended to June 30, 1894	851,210.62

Money statement.

July 1, 1894, balance unexpended		$572.84
Amount appropriated by act of August 17, 1894		20,000.00
		20,572.84
June 30, 1895, amount expended during fiscal year		13,464.91
July 1, 1895, balance unexpended		7,107.93
July 1, 1895, outstanding liabilities	$425.00	
July 1, 1895, amount covered by uncompleted contracts	2,111.99	
		2,536.99
July 1, 1895, balance available		4,570.94
Amount (estimated) required for work annually		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of bids for subsistence supplies for removing obstructions in Arkansas River, Arkansas and Kansas, received in response to advertisement dated March 28, 1895, and opened April 18, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
*1	James E. Joyce & Co., Little Rock, Ark	$2,111.99	+$30.93	$2,142.91
2	H. J. George & Co., Little Rock, Ark	2,255.23	+ 28.80	2,284.03
3	The Charles F. Penzel Grocer Co., Little Rock, Ark	2,309.37	+ 11.80	2,321.17
4	Porter & Macrae, Memphis, Tenn	2,274.32	— 82.91	2,190.41

*Recommended for acceptance. Contract entered into May 18, 1895, approved May 23, 1895; terminates March, 1896.

Abstract of bids for hardware and ship chandlery supplies for removing obstructions in Arkansas River, Arkansas and Kansas, received in response to advertisement dated May 5, 1895, and opened May 21, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	Dudley E. Jones Co., Little Rock, Ark	$3,538.52	—$569.91	$2,968.61
*2	Dickinson Hardware Co., Little Rock, Ark	2,641.74	— 89.76	2,589.98

*Recommended for acceptance. Contract entered into June 29, 1895, not yet approved.

COMMERCIAL STATISTICS.

The commerce for the year ending May 31, 1895, is reported under the head "Improvement of Arkansas River."

V 2.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

PRESENT WORKS.

ABOVE FORT SMITH, ARKANSAS.

At Ainsworth Crossing, near Holts Rock, on right bank, 18½ miles above Fort Smith.—Two brush and stone dikes, 400, and 500 feet; total, 900 feet; built in fiscal years 1891, 1892. Repaired 1895.

Bruces Island, on left bank, 12 miles above Fort Smith.—One permeable dike, 350 feet long, in Cherokee Chute; built in fiscal year 1890. Never repaired.

Poteau Reach, on left bank, ¼ to 3½ miles above Fort Smith.—Six dikes, 320, 450, 600, 420, 300, and 1,150 feet; built permeable in fiscal years 1887, 1890, 1891 (total, 3,240 feet). Four of these, 320, 450, 600, and 420 (total 1,790), converted into solid stone-capped dikes in fiscal year 1893; two 300 and 1,150, (total, 1,450) feet still permeable, and never repaired. Also one stone and brush dike 1,100 feet long, with training wall 1,000 (total, 2,100 feet), built in fiscal years 1878, 1879 to 8-foot stage. Present height about 4-feet stage.

FROM LITTLE ROCK, ARK., TO FORT SMITH, ARK.

At Fort Smith, near Old Wharf—One brush and stone dike, 131 feet long; built in fiscal year 1885 to 12-foot stage. Present height about 2.5-foot stage.

Van Buren, on right bank, 178 miles above Little Rock.—Two solid stone-capped dikes, 900 and 600 feet; total, 1,500 feet. One dike, 900, feet was built for a railway incline; the other, 600, feet was built permeable in fiscal year 1889. Both converted into solid stone-capped dikes in fiscal years 1893, 1894.

Moores Rocks, 168 miles above Little Rock.—One channel, 75 feet wide, 425 feet long, excavated to a depth of 2 feet at low water in fiscal years 1891–1893.

Dardanelle Reach, on left bank, 88 to 89 miles above Little Rock.—Three solid stone-capped dikes, 250, 200, and 140 feet, total, 590 feet. One, 250 feet, built of riprap stone on brush mattress foundation in fiscal year 1894; one, 200 feet, was built permeable in fiscal year 1887, converted into stone-capped dike in fiscal years 1893, 1894; one, 140 feet, an old steamboat wharf, broken near shore, converted into stone dike in fiscal year 1894.

Head of Rectors Island, on right bank, 13½ miles above Little Rock.—One solid dike, 500 feet long, and one dam, 700 feet long, across right-hand chute, both of riprap stone on brush mattress foundation; built in fiscal year 1895.

Crystal Hill, on left bank, 11½ miles above Little Rock.—Two dikes, 300 and 700 feet long (total, 1,000), built of riprap stone on brush mattress foundation in fiscal years 1894, 1895.

Greathouse Bend, 6½ miles above Little Rock.—One bank revetment 3,273 feet long; built in fiscal year 1895.

Above Baring Cross Bridge, on right bank, 1¾ to 2¾ miles above Little Rock.—Five stone dikes, 240, 150, 320, 135, and 150 feet; total, 995 feet. Three of these, 240, 320, and 135 feet, built permeable in fiscal years 1888, 1889, repaired in fiscal year 1892, and converted into stone-capped dikes in fiscal year 1893. Two, 150 and 150 feet, built of stone on brush mattress foundation in fiscal year 1893; all repaired in fiscal year 1894.

FROM LITTLE ROCK, ARK., TO MOUTH.

Reach below Little Rock Junction Railway Bridge, on left bank, no miles to 1 mile below Little Rock.—Four dikes, 400, 260, 250, and 400 feet, built as permeable dikes in fiscal years 1888, 1889; converted into

solid stone-capped dikes in fiscal year 1893. Each dike was built 400 feet long; the two shorter dikes were filled to the remaining lengths of the original structures.

Meads Point, on right bank, 1¾ miles below Little Rock.—One permeable dike 200 feet long; built in fiscal year 1888. Never repaired.

Eagle Bend, on left bank, 20½ miles below Little Rock.—Two permeable dikes, 600 and 394 feet; total, 994 feet; built in fiscal year 1888. Never repaired.

White Bluff, on left bank, 43 miles below Little Rock.—Two permeable dikes, 200 and 400 feet; total, 600 feet; built in fiscal year 1888. Never repaired.

Pine Bluff Reach, on right bank, 65 to 67 miles below Little Rock.—Six dikes, 1,520, 400, 200, 150, 150, and 150 feet; total, 2,570 feet. One dike, 1,520 feet; built in fiscal year 1885; 400 feet of brush and sand boxes and 1,120 feet permeable; repaired in fiscal year 1887; still permeable. Five dikes, 400, 200, 150, 150, and 150 feet, are now solid stone-capped dikes. Three of these, 400, 200, and 150 feet, built permeable in fiscal years 1885, 1890, 1891. One, 400 feet, repaired in fiscal year 1892 and converted into solid stone-capped dike in fiscal year 1893. Two, 200 and 150 feet, converted into brush and sand-box dikes in fiscal year 1891 and into solid stone-capped dikes in fiscal years 1892, 1893. The last two, 150 feet each, built of brush and sand boxes in fiscal year 1892, converted into solid stone-capped dikes in fiscal years 1893, 1894.

Two bank revetments, 7,395 feet long in all. One 2,115 feet, from Dike 4 to Dike 6, built in fiscal years 1893, 1894. One beginning 600 feet below Dike 6, extending downstream 5,280 feet, built in fiscal year 1892; repaired in fiscal year 1894.

Furgus Place Reach, on right bank, 68 to 69 miles below Little Rock.—Four permeable dikes, 450, 800, 800, and 807 feet; total, 2,857 feet; built in fiscal year 1891; repaired in fiscal year 1892. One, 450 feet, repaired in fiscal years 1893, 1894 by stone filling.

Rob Roy Reach, on right bank, 73¾ miles below Little Rock.—One permeable dike 1,200 feet long; built in fiscal year 1891. Never repaired.

Red Fork, on right bank, 148.6 miles below Little Rock.—One bank revetment 4,800 feet long; built in fiscal year 1895.

OBJECT OF IMPROVEMENT.

To secure a navigable channel not less than 6 feet in depth from Little Rock to Mississippi River via White River Cut-off and not less than 2 feet in depth above Little Rock.

GENERAL PROJECT.

Prior to 1886 works upon this river were special improvements of detached reaches, generally with immediate reference to confining the channel to draw spans of bridges, or to the water fronts of towns having quays, and to the improvement of some especially difficult crossing.

The act which became a law August 11, 1888, adopted the plans set forth in Appendix V 13, Annual Report Chief of Engineers for the fiscal year 1885, and in House Ex. Doc. No. 90, Forty-ninth Congress, first session (the former relating to the reach "from Little Rock to the Mississippi River via the White River Cut-off," the latter to the reach from Fort Gibson to Wichita, Kans.), and authorized the application of available balances of former appropriations to this work, adopting as a part of it the works already constructed under those appropriations.

These plans were for removal by blasting and dredging of rock and gravel reefs, contraction by permeable dikes as used on the Mississippi River, or by brush and stone dams, no mention being made of revetment except by implication in the references to the Mississippi River. The works constructed under these appropriations by the officer presenting the plans show high permeable dikes, similar dikes subsequently solidly filled with stone, low dikes originally built of riprap upon mattress foundations, brush and stone dams, and a sparing use of revetment. Works of all these types were constructed and reported before the appropriation of July 13, 1892.

In view of the above action, the adopted project is to remove rock and gravel reefs by blasting and dredging, to contract the channel by dikes or dams, permeable or solid, of such construction as the local conditions require, and to hold the channel so obtained by revetment where necessary. The works to be carried on under special projects.

SPECIAL PROJECTS OF THE FISCAL YEAR.

ABOVE FORT SMITH, ARK.

At Ainsworth Crossing.—Repair dikes erected in fiscal years 1891, 1892.

Poteau Reach.—Restore Suter Dike and 500 feet of its training wall; erect at the downstream end of the restored portion of training wall a cross dike extending 300 feet into the river and back to the high bar; also erect in the pocket in the right bank above the mouth of Poteau River two dikes each 200 feet long. The dikes to be built of riprap stone on brush mattress foundation; the Suter Dike and training wall to be restored by using riprap stone and quarry spawls.

FROM LITTLE ROCK, ARK., TO FORT SMITH, ARK.

Between Palarm Creek and Cribbs.—Protect about 7,500 feet of bank by revetment, using brush mattress 60 feet wide and riprapping bank to 15-foot stage.

Reach between Big Rock and Rectors.—First project: Erect from left bank near Crystal Hill two riprap stone dikes on brush-mattress foundation, the upper one (E) to be 300 feet long, the lower one (F) to be 400 feet long. Second project: Erect at head of Rectors Island from right bank one dike 500 feet long and one dam across right-hand chute; near Crystal Hill complete Dike E and extend Dike F 300 feet. Dikes and dam to be of riprap stone on brush-mattress foundation. At Greathouse Bend protect about 3,400 feet of bank by revetment, using brush mattress 60 feet wide and riprapping bank to 15-foot stage.

BELOW LITTLE ROCK, ARK.

Reach below Little Rock Junction Railway Bridge.—Render permanent Dikes Nos. 1, 2, 3, and 4.

Furgus Place Reach.—Remove Dike A° and revet about 3,650 feet of bank, beginning 2,400 feet below Lone Tree. Brush mattress 120 feet wide to be used, riprap to be carried to 15-foot stage.

Red Fork.—Protect 4,800 feet of bank by revetment, using brush mattress 120 feet wide and riprapping bank to 20-foot stage. Nearly completed.

OPERATIONS OF THE FISCAL YEAR.

ABOVE FORT SMITH, ARK.

Snagging operations by the snag boat Wichita.—This boat began work at Fort Smith June 7, 1895, and worked between that point and Bruces

Island until the 15th, when it was temporarily laid up on account of a small rise in the river until June 25. After this date the boat worked up to Pettis Reach. One hundred and forty-five snags were removed.

Ainsworth Crossing.—The work at this point was that of repairing Dikes Nos. 7 and 8, erected in fiscal years 1891, 1892, and consisted of riprapping the bank to 20-foot stage from a point 50 feet above to a point 100 feet below the center line of the dikes and also filling the depressions in the dikes, restoring them to the original height, 4 feet above low water. The stone used was purchased on 10-day circular, the delivery being made in the work, Government barges being used to transport the stone.

Statement of field expenditures, repairing dikes at Ainsworth Crossing.

Dike.	Began.	Completed.	Stone used.	Cost per unit.	Inspection.	Total
	1895.	1895.	*Cubic yds.*			
7	June 13	June 26	465.47	$1.09	$43.87	$551.23
8	May 27	June 24	551.34	1.09	51.96	652.92
Total						1,204.15

Total cost of stone in place per cubic yard, $1.184.

Near Fort Smith.—Here a sand bar from the right bank of the Arkansas River and from the left bank of the Poteau River prevented the passage of boats through the drawspans of the Arkansas Valley Railway Bridge, when the river was at less than 4-foot stage. To remove this bar, the work set forth under the head "Special projects of the fiscal year, Poteau Reach," is now in progress. It was begun the middle of April. The material was purchased on 10-day circular, the stone and quarry spalls to be delivered in the work and the brush and poles on Government barges at the work. The mattresses were woven and the banks graded by hired labor employed by the Government. The mattress weaving was completed May 21, but the delivery of stone has not progressed as rapidly as hoped for, being delayed by rises in the river in June. In the restoration of the Suter Dike (built in fiscal years 1878, 1879) and erection of cross dike on its training wall 37,718 square feet of mattress was woven, using 165 cords of brush, and up to close of the fiscal year 3,277 cubic yards of stone and 404 cubic yards of spalls have been placed. In the erection of the dikes in the pocket above the mouth of Poteau 39,300 square feet of mattress was woven, using 194.75 cords of brush, and to the close of fiscal year 524 cubic yards of stone and 70 cubic yards of spalls have been placed.

FROM LITTLE ROCK, ARK., TO FORT SMITH, ARK.

The work between Little Rock and Fort Smith during the fiscal year has been confined to the first 21 miles above Little Rock, the object being to make the improvements continuous from that city.

Map showing the works erected in previous years and in the fiscal year and the work in progress and proposed for this reach of river is inclosed herewith.

Fletchers Bend, between Palarm Creek and Cribbs.—No work was done under this special project. Ten barges were transported from Pine Bluff to Little Rock for use in this work. The proposals for furnishing the materials required were opened June 10, 1895, but no contracts have yet been made.

Abstract of proposals for furnishing and delivering brush, poles, and piles at the work in Fletchers Bend, between Palarm Creek and Cribbs, opened June 10, 1895, by First Lieut. William L. Sibert, Corps of Engineers.

No.	Name and address of bidder.	Brush.		Poles.		Piles.		Total.
		Per cord.	Cost.	Each.	Cost.	Per linear foot.	Cost.	
1	Zeb. Ward, jr., Little Rock, Ark..	$1.49	$3,129.00	$0.06	$292.50	$0.06	$240.00	$3,661.50
*2	Harvey Lewis, jr., Roland, Pulaski County, Ark.....	.....	.....	.....	.....	.06	240.00	.....
3	Joseph Evins, Mount Nebo, Ark..	1.75	3,675.00	.08	390.00	.10	400.00	4,465.00

* No. 2 incomplete. Bid No. 1 recommended for acceptance.

Abstract of proposals for furnishing and delivering riprap stone and small stone at the work in Bend, between Palarm Creek and Cribbs, opened June 10, 1895, by First Lieut. William L. Sibert, Corps of Engineers.

[Whole quantity by use of Government barges.]

No.	Name and address of bidder.	Riprap stone.		Small stone.		Added for use of Government barges.		Total used in canvassing proposals.
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	No.	Amount.	
1	Harvey Lewis, Little Rock, Ark., and Leonard Adams, 1400 Louisiana street, Little Rock, Ark...	$0.80	$7,320.00	$0.80	$1,880.00	8	$460.00	$9,660.00
2	Fred Hanger, Little Rock, Ark....	.97	8,775.50	.97	2,279.50	8	460.00	11,615.00
3	J. W. Roberts, 1824 Battery street, and A. J. Miears, 2118 Arch street, Little Rock, Ark	.....	.....	.....	.....	3	172.50	.....
4	Joseph Evins, Mount Nebo, Ark...	1.29	11,803.50	1.39	3,266.50	8	460.00	15,530.00
*5	Zeb. Ward, jr., Little Rock, Ark...	.....	.....	.....	.....	.....	.....	.....

[Whole quantity by use of private plant.]

*1	Harvey Lewis, Little Rock, Ark., and Leonard Adams, 1400 Louisiana street, Little Rock, Ark	.....	.....	.....	.....	.....	.....	.....
*2	Fred Hanger, Little Rock, Ark	.....	.....	.....	.....	.....	.....	.....
3	J. W. Roberts, 1824 Battery street, and A. J. Miears, 2118 Arch street, Little Rock, Ark	$0.78	$7,137.00	$0.78	$1,833.00	....	.....	$8,970.00
*4	Joseph Evins, Mount Nebo, Ark...	.....	.....	.....	.....	....	.....	.....
5	Zeb. Ward, jr., Little Rock, Ark....	.79	7,228.50	.79	1,856.50	....	.....	9,085.00

[Portion of quantity by private plant and portion by use of Government barges.]

*1	Harvey Lewis, Little Rock, Ark., and Leonard Adams, 1400 Louisiana street, Little Rock, Ark.....	.....	.....	.....	.....	.....	.....	.....
*2	Fred Hanger, Little Rock, Ark	.....	.....	.....	.....	.....	.....	.....
3	J. W. Roberts, 1824 Battery street, and A. J. Miears, 2118 Arch street, Little Rock, Ark	.....	.....	.....	.....	3	$172.50	.....
*4	Joseph Evins, Mount Nebo, Ark...	.....	.....	.....	.....	....	.....	.....
*5	Zeb. Ward, jr., Little Rock, Ark....	.....	.....	.....	.....	....	.....	.....

* No proposal for this manner of delivery.

No. 3 makes proposal to furnish whole quantity by private plant and partially fills out proposals for other manners of delivery. One copy of proposal bears erasures. Each guarantor does not justify in the sum of 25 per cent of the amount bid. In the body of the guarantee the names of the bidders are not written out in full. Signature of one guarantor not witnessed.

No. 5. One guarantor does not justify in the sum of 25 per cent of the amount bid. Recommended for acceptance.

No. 1. One name is red-lined out and another written in in the guarantee, justification of guarantors, and in the certificate.

Head of Rectors Island.—For the purpose of confining the entire flow of the Arkansas River, when at 7-foot stage or less, to Rectors Chute, one dike 500 feet long and one dam across the right-hand chute are now under construction. Both dike and dam are built of riprap stone on brush mattress foundation, are 8 feet wide on top, and built to 7-foot stage. The bank at the root of both dike and dam is revetted 50 feet above and 100 feet below the center line in each case; riprap carried to 20-foot stage. The mattress used in the revetment is 60 feet wide; that used in the foundation for the dike is 76 feet wide; that used in the dam proper is 60 feet wide. A mattress 40 feet wide and 600 feet long extends from the bar end of the dam across the bar, and is covered with a closely laid layer of riprap stone 12 inches thick. A mattress making an angle of about 79° with the bar end of dam, following the crest of the bar downstream for 200 feet, is built and covered with a 12-inch layer of stone. The work is nearly completed. The slopes of the dike are not yet finished.

The dam is completed for a length of 400 feet, all of the 40-foot mattress has been covered with a layer of riprap stone, and about 100 feet of the 60-foot mattress remains to be covered. The stone required to complete the work has been delivered at the site of the work.

Statement of material used in work at head of Rectors Island.

Material.	Dike.	Dam.
Mattress, woven.....square feet..	50,344	80,100
Mooring piles	10	8
Cords of brush	222.8	403.2
Number of poles	580	800
Riprap stone.....cubic yards..	3,088.4	3,398.3

Five hundred additional cubic yards of riprap stone has been delivered at the site of the dike, but not placed.

Crystal Hill.—October 8, 1894, to February 28, 1895. Constructing Dike F and completing Dike E. The brush, poles, and stone for this work were purchased by ten-day circular. Part of the brush and poles were delivered on barges at Rectors Island (1½ miles above the work) and part on barges at the work. The stone was delivered in place in the work. The work was done under two special projects, one of which provided for a dike (F) 400 feet long and the other for extending this dike 300 feet. At the time of building the foundation mattress for the first 400 feet of dike the bar was so soft that it was covered with brush tops to afford a footing for the laborers weaving the mattress, and during the entire work the brush barges could not approach the mattress any closer than an average distance of 350 feet. As completed, Dike F consists of 150 feet of bank protection, riprap carried to a 20-foot stage, one shore mattress 40 feet wide and 150 feet long, entirely covered with stone to a thickness of 9 inches; one foundation mattress 40 feet wide and 440 feet long, and one foundation mattress 60 feet wide and 280 feet long. The portions of the mattresses that extend beyond the foot of the slopes of the dike are entirely covered with stone to a thickness of 9 to 12 inches. The average height of dike above the bar is 4.6 feet; the top length is 700 feet; top width, 8 feet; the first 400 feet is built to a height of a little above the 8-foot stage (this to correspond with height of Dike E); the dike then slopes to a 7-foot stage at the outer end.

The work done at Dike E was that of raising with riprap stone the end near shore to about the general height of the dike and reenforcing

the shore protection with a mattress 40 feet wide and 60 feet long, ballasted with stone.

Exhibit of field expenditures, completing Dike E.

Labor, supervision, subsistence, etc	$18.85
15 cords brush, at $1.35 per cord	20.25
35 poles, at 8 cents each	2.80
248.8 cubic yards stone, at 99 cents per cubic yard	246.31
Total	288.21

Exhibit of field expenditures, Dike F, near Crystal Hill.

	Per unit.	Total, each item.	Total cost.
Grading bank.			
Labor, including subsistence, supervision, etc		$32.23	$32.23
Mattress.			
125 cords brush on barges at Rectors Island	$1.350	168.75	
117 cords brush on barges at the work	1.120	131.04	
235 poles on barges at Rectors Island	.080	18.80	
91 poles on barges at the work	.058	5.28	
140 pounds wire		4.56	
Labor, cordelling brush and poles from Rectors Island		20.51	
Labor, weaving mattress		483.75	
Total cost of mattress, 40,800 square feet			832.69
Stone.			
1,523 cubic yards in place in the work	.990	1,507.77	
1,175 cubic yards in the work	.675	792.62	
Inspection		243.11	
Total cost of riprap stone	.943		2,543.50
Miscellaneous.			
Repairs to range			16.00
Property purchased			39.00
Total field expenditures			3,463.42

Brush used per 100 square feet of mattress, 0.5931 cord.
Cost per 100 square feet of mattress, $2.041.
Labor per 100 square feet of mattress, $1.236.
Cost of dike per linear foot, $4.948.
Labor, weaving 1 cord of brush, $1.999.

Greathouse Bend.—January 2 to March 26, 1895, constructing 3,273 linear feet of revetment. Brush and poles purchased on ten-day circular, delivery being made on barges at the work. 3,139.7 cubic yards of stone purchased in same manner, delivery being made in the work. The rest of the stone was purchased in open market, delivery being made on barges at Ives Point and Crystal Hill. The original plan for the work was to place a brush mattress, 60 feet wide from the water line out, and to grade and riprap bank to 15-foot stage. On account of slowness in delivery of stone and a threatened rise in river, this was modified by placing a bank mattress above the water line to a 7-foot stage for a distance of about 875 feet, beginning at 400 feet below the head of revetment.

Between January 26 and February 22, mattress weaving was temporarily suspended on account of slowness in delivery of stone and excessive cold weather. On the latter date all the ice had passed out of the river and, arrangements having been made for procuring stone at Ives Point and Crystal Hill, work was resumed and continued without

interruption to completion. The bank protected by this revetment is very unstable, being entirely of sand, excepting about 300 feet at the head of the work. Surface water flowing over the bank washes the bank badly and it is very probable that extensive repairs will be required to the riprap during the coming year.

Exhibit of field expenditures, Greathouse Bend revetment.

	Per unit.	Total, each item.	Total cost.
Grading bank.			
Labor, including supervision, subsistence, etc			$1,278.71
Filling holes in bank.			
90 cords brush on barges at the work	$1.125	$101.25	
Labor, placing brush		32.04	
			133.29
Mattress.			
1,077 cords brush on barges at the work	1.125	1,211.62	
2,122 poles on barges at the work	.0625	132.62	
4,140 pounds wire		76.32	
Labor, weaving 196,380 square feet of water mattress		837.13	
Labor, weaving 13,131 square feet of bank mattress		101.34	
			2,359.03
Anchor piles.			
77 piles (20 feet long)	1.90	146.30	
Labor, driving 71 piles	2.294	162.89	
Fuel (estimated, paid for fiscal year 1894, Dardanelle dikes)	.282	20.00	
Total cost of anchor piles	4.036		329.19
Ballasting mattress and bank.			
497.2 cubic yards spawls in place in the work	.59	293.35	
2,442.5 cubic yards riprap stone in place in the work	.49	1,196.82	
200 cubic yards riprap stone on bank at the work	.49	98.00	
Inspection and measurement of stone	.07	221.21	
1,669.2 cubic yards stone on barges at Ives Point	.40	667.68	
286 cubic yards stone on barges at Crystal Hill	.45	128.70	
Towage of 1,955.2 cubic yards stone	.521	1,018.08	
Labor, ballasting mattress and bank with 2,155.2 cubic yards stone	.259	557.15	
Total cost of stone in place	.821		4,180.99
Miscellaneous.			
Survey			17.66
Property purchased			185.72
Repair to plant (carpenters and material)			178.45
Total field expenditures on revetment			8,663.04

Brush used per 100 square feet of mattress, 0.514 cord.
Cost of mattress per 100 square feet, $1.126.
Labor, per 100 square feet of mattress, $0.448.
Cost to grade bank per linear foot, $0.391.
Cost of completed work per linear foot, $2.647.
Labor, weaving 1 cord of brush, $0.871.

BELOW LITTLE ROCK, ARK.

Other than care of property at Pine Bluff, the only work done below Little Rock was that of revetting 4,800 feet of bank in Red Fork Bend. The object of the work being to arrest caving of the right bank of this bend at points where the levee was in danger of caving into the river. It was imperative that the work be done as soon as possible, to have the protection in place before the spring freshets. Stone was procured on ten-day circular, the delivery being made on river bank at Arkansas City. It was loaded on barges at that point by hired labor and towed

to Red Fork via White River, 45.1 miles over the Mississippi, 7.8 miles over the White, and 17 miles over the Arkansas by Government and chartered boats. The brush, poles, and piling were purchased under ten-day circular, delivery to be at the works, the brush and poles on Government barges and the piling on the bank. Some brush was cut by hired labor on account of slowness in delivery. The Government plant used was taken from Little Rock, Pine Bluff, and Clarendon, Ark., in the latter part of October, but, on account of delays incident to shoal water and a channel full of snags, revetment work did not begin until November 23. The snag boat *Beauregard*, after cleaning out a channel through the Cut-off, was transferred to this work on January 8 to assist the chartered steamer *S. P. Pond* in towing stone. After the new boiler was placed on the U. S. towboat *Cleveland* this boat was also sent to Red Fork.

The first work assigned to her was towing a crippled barge to Memphis, where she was caught in the ice until February 19. Upon her return to Red Fork on February 22, 1895, the chartered steamer *S. P. Pond* was returned to Newport and the towing completed with the *Cleveland* and *Beauregard*, the latter-named boat doing the towing between Arkansas City and the mouth of the Cut-off, the former towing between the mouth of Cut-off and Red Fork.

The low water of December and first half of January was a great drawback; the stone barges could be loaded to only about half their capacity. Towing up White and Arkansas rivers was slow and tedious on account of the many snags. Three barge loads of stone were lost in the Cut-off by the sinking of three barges, two of which were not raised. The January rise in the Mississippi River, while it gave better water in the Arkansas River, did not relieve the towing of its dangers, for in the slack water no breaks or rolls showed the location of snags and stumps. The plan of the work was that of weaving and weighting a brush mattress 120 feet wide from the water line out, grading the bank to 20-foot stage, and covering the graded portion with riprap stone, closely laid.

The mattress was anchored to mooring or stay piles spaced 25 feet apart. As the work stands at the close of the fiscal year, 2,400 feet of the bank is protected by mattress sunk at low water and 2,000 feet is protected by mattress that was sunk when the river was from the 3 to 16 foot stage. All the bank above the mattress, excepting 250 feet, is protected by riprap to the 20-foot stage.

The 250 feet not protected by riprap is protected temporarily by stone-weighted mattress. With the exception of riprapping that portion of the bank above low water protected only by mattress, the work is completed. The *Beauregard* left Arkansas City on March 29 with the last tow of stone. The *Cleveland*, on the same date, left Red Fork with the plant belonging to Little Rock fleet. The chartered barges were returned to Memphis, and the plant belonging to the White River fleet was taken to Newport by the *Beauregard* in April.

The chartered plant used on the work was the steamer *S. P. Pond* and four barges, 100 by 24 by 5½. The steamer was under charter 123 days, and the total charter time of barges was 364½ days.

Expense bill for Red Fork revetment.

Description of work.	Cost per unit.	Cost, each item.	Total cost.
Grading bank.			
Labor, supervision, subsistence, etc		$2,016.25	$2,016.25
Mattress.			
2253.64 cords brush on barges at work	$2.25	5,070.69	
5140 poles on barges at work	.15	771.00	
Labor cutting 551.25 cords brush	1.224	686.93	
12,926 pounds wire	.02142	276.87	
10 kegs nails	2.27	22.70	
Labor weaving 587,490 square feet mattress		2,258.35	
			9,086.54
Stone.			
8,466.793 cubic yards stone on bank at Arkansas City	1.54	13,038.86	
125.186 cubic yards stone on bank as above	1.00	125.19	
250 cubic yards stone on barges at Clarendon	.85	212.50	
Labor loading stone at Arkansas City (8,591.979 cubic yards)	.223	1,916.68	
Runways at Arkansas City (labor, material, etc)		75.74	
Expense steamer S. P. Pond, towing		6,169.64	
Expense steamer Beauregard, towing		3,287.00	
Expense steamer Cleveland, towing		961.19	
Charter of barges		1,458.00	
			27,244.80
Ballasting mattress and bank.			
Labor, ballasting with 8,491.979 cubic yards stone	0.158	1,349.51	
			1,349.51
Anchor piles.			
200 piles (20 feet long)	1.50	300.00	
Labor driving piles	1.4259	285.18	
Fuel		7.50	
			592.68
Miscellaneous.			
Expense Beauregard raising sunken barge		305.07	
Expense Cleveland towing crippled barge to Memphis		529.33	
Labor and material repairing barge		377.64	
Transfer of plant from and to White River		2,855.22	
Transfer of plant from and to Little Rock		842.70	4,909.96
Total field expense			45,199.74

Brush used per 100 square feet of mattress, 0.479 cords.
Cost of mattress per 100 square feet, $1.547.
Labor per 100 square feet of mattress, $0.384.
Cost to grade bank per linear foot, $0.42.
Cost of completed work per linear foot, $9.416.
Labor, weaving one cord of brush, $0.802.

PLANT.

The plant formerly held under the head "Removing obstructions in Arkansas River, Arkansas and Kansas," having been by authority consolidated with that under the head "Improving Arkansas River," the repairs to all are reported regardless of appropriation under which the plant had been employed during this year.

Snag boat Wichita.—Docked; roof recanvased, 100 feet of port gunwale and 45 feet of starboard gunwale, 5 rake planks, 25 bottom planks, 38 floor beams, all deck beams and hull stanchions forward of boiler, plank shear and nosing, all deck on guards and forecastle renewed. Cold-water pumps of the doctor rebored, new Snowden heater placed in boilers, and cylinders of 10-inch bore placed in engines. One rudder renewed and wheel rebuilt. Cabin arranged to accommodate entire crew on boiler deck; all bulkheading on main deck forward of engine room removed, making open deck room between boilers and engine room. All deck beams aft of boilers spliced and cylinder timbers braced.

Snag boat Beauregard.—One new shaft for doctor, cold-water pumps of doctor rebored. Cabin arranged as in *Wichita*. Boilers re-covered and boiler furnace rebuilt. Piston heads arranged for and fitted with spring packing. An electric light plant consisting of one 6 by 6 Racine upright automatic engine, one 60-ampere commercial dynamo, one search light, 4 arc lights, 24 16-candle-power incandescent lights, and station apparatus placed on boat. Painting of boat and recanvasing roof now in progress.

Tow boat Cleveland.—Calked above water line, new boiler, stacks, steam pipes, and throttle placed on the boat. Engines thoroughly overhauled, new plunger and valves put in Hooker pump. Also minor repairs necessary to keep boat in commission. Painting of boat now in progress.

Snag boat Missouri.—Roof recanvased, boiler tubes expanded, capstans overhauled. New deck forward of boiler and on guards.

Quarter boat Lisette.—Calked above water line, new deck forward and aft and on guards, and new nosing.

Quarter boat Charleston.—Calked above water line, new deck forward and aft, and roof canvased.

Store boats (3).—Calked and decks repaired.

Barges (60 by 20 by 3).—Nos. 100 to 125, inclusive, calked, decks and rakes repaired.

Barges (100 feet 4 inches by 25 feet by 5 feet).—Nos. A195 to A395, inclusive, built during the months of May and June. Barge No. A495 is now constructing.

Pile Driver No. 2.—Calked above water line.

Pile Driver No. 3.—Boiler fitted with new tubes, engine overhauled, and minor repairs made, hull calked above water line.

Pile Driver No. 4.—Hull calked above water line. Machinery and boiler off of sunken Driver No. 1 placed on this one.

Hydraulic grader.—The Worthington pump off of the snag boat *C. B. Reese* was transferred to Little Rock in June, the intention being to use it for hydraulic grading. Barge 113 was fitted with four beams and two gallus frames, and the pump placed on this barge.

The boiler from the sawmill at the Little Rock boat yard is to be used for supplying steam to the pump.

Plant sunk.—One barge (60 by 20 by 3), Pile Driver No. 1, and one barge (100 by 30 by 5), all old.

CHANNEL.

The Arkansas River is a stream whose bed and banks are to a great extent composed of a sandy loam. This material is eroded very easily, and as a result the channel of the stream is continually changing, the concave banks wearing away, and the opposite point bars building out.

From Little Rock to the mouth (173 miles) the river valley is entirely alluvial, and the entire bank is liable to cave if attacked by the water. Above Little Rock the conditions are the same, except at those places where the stream runs next to the hills that jut out into the valley. Even though the valley be very narrow, the character of the bottom land is the same.

From the data in the possession of this office, which is not very complete, the average amount of bank caved in per mile per year from Little Rock to the mouth is about 7.64 acres; from Little Rock above, about 1.99 acres.

Ordinarily in low water there is approximately 3 feet of water on the shallowest crossings from the mouth to Silver Lake, a distance of about

40 miles; from there up to Webers Falls, in Indian Territory, there is no great difference in depth, being about 16 inches on the shallowest crossings to 20 miles above Little Rock, and 12 to 14 inches from there on up. The increased depth in the lower 40 miles of the river is evidently due to the effect the backwater from the Mississippi has on this portion of the stream.

The checking of the current by this backwater causes immense deposits of material in that portion. When a concave bank wears away, the opposite point bar builds up in two or three years to near the height of the original bank, thus keeping the river bed narrow; while above where this condition exists the high concave banks wear away and the bars opposite build up very slowly, and, as a consequence, when the river rises 2 or 3 feet it spreads out until it is wider than in the lower part of the stream.

This condition of course requires more rainfall to produce a navigation depth and causes in a great many cases a different channel in high and low water, leveling the bars and filling up the low-water channel to such an extent as to make it a difficult task for the low-water current to cut out its original channel.

The low-water channel as a consequence wanders between these high banks after different rises.

While engaged in snagging operations between Little Rock and Pine Bluff the snag boat *Sheldon* reported 19 inches over Fourche Bar October 12; 18 inches over Wild Cat October 27; 16 inches over Wrights Crossing November 1; 18 inches on Kings Bar and Wrights November 12. The Signal Service gauge at Little Rock was 3.6 feet on the first-mentioned date and 2.6 feet on that last mentioned. In May the towboat *Cleveland* (draft forward 18 inches and aft 20 inches) returned from St. Francis River and encountered considerable difficulty in reaching Little Rock. Extracts from the log are: "May 21, lost two hours on Victoria Bar; worked rest of day on Rob Roy Bar. May 22, pulled over Rob Roy Bar at 10.30 a. m.; lost two hours on Furgus Bar. May 24, all day on Kings Bar. May 25, lost four hours on Cates Bar. May 26, can't get over Fourche Bar."

The Signal Service gauge at Little Rock read from 2.8 feet to 3 feet during the time, and all commercial navigation was suspended.

COMMERCE.

The commerce of the river follows, with little overlapping, the divisions of the appropriation bills. The river traffic of the section above Fort Smith centers at that city, which also draws upon the lower river as far as Dardanelle. The traffic on the section from Little Rock to Fort Smith is by lines of steamers owned at Little Rock and running also to Pine Bluff. The principal traffic from Little Rock to the mouth is by a line of steamers running from Pine Bluff to Memphis.

The principal traffic is in cotton (plantation bales), cotton seed, rough lumber and logs (hard and soft woods), brought to the three centers above mentioned, and provisions and general merchandise carried out thence. From all the centers the finished products, pressed bales, oil, finished lumber, barrel staves, etc., are generally sent out by rail.

The commerce reported this year is very small on account of continued low water. Steamboats running out of Little Rock report only 148 days in which they could do any business. The Memphis and Pine Bluff packet was unable to reach Pine Bluff 95 days during the year.

APPROPRIATIONS AND EXPENDITURES.

Prior to 1886 appropriations were for special works. The act of August 5, 1886, appropriated for the whole river, making allotments for certain of these works. The act which became a law August 11, 1888, adopted these works and authorized the application of their balances to the general improvement.

The appropriations for works embraced in the present project are as follows:

June 14, 1880 (Pine Bluff)...	$25,000 00	July 13, 1892.....	$250,000.00
March 3, 1881 (Pine Bluff)..	23,000.00	August 17, 1894.....	250,000.00
August 2, 1882 (Pine Bluff).	20,000.00	Sale of United States quarter boats.....	5,000.00
July 5, 1884 (Pine Bluff)...	55,500.00		
July 5, 1884 (Fort Smith)..	5,000.00		
August 5, 1886.....	75,000.00	Total	1,038,500.00
August 11, 1888.....	150,000.00	Expended to June 30, 1894..	772,624.07
September 19, 1890.....	180,000.00		

Money statement.

July 1, 1894, balance unexpended.....		$15,875.93
Amount appropriated by act of August 17, 1894.....		250,000.00
Received on account of deposit made by First Lieut. William L. Sibert.		17.71
		265,893.64
Reserved in United States Treasury for freight charges.....	$18.60	
June 30, 1895, amount expended during fiscal year.....	100,795.39	
Purchase of 250 cubic yards of riprap stone.....	212.50	
		101,026.49
July 1, 1895, balance unexpended.....		164,867.15
July 1, 1895, outstanding liabilities.....	$10,000.00	
July 1, 1895, amount covered by uncompleted contracts.....	10,103.70	
		20,103.70
July 1, 1895, balance available.....		144,763.45
Amount (estimated) required for completion of existing project.....		2,972,479.00
Amount that can be profitably expended in fiscal year ending June 30, 1897.....		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of bids for subsistence supplies for improving Arkansas River, Arkansas, received in response to advertisement dated March 28, 1895, and opened April 18, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	Jas. E. Joyce & Co., Little Rock, Ark.....	$10,862.72	—$20.78	$10,841.94
2	H. J. George & Co., Little Rock, Ark.*.....	10,103.70	— 36.68	10,067.02
3	The Chas. F. Penzel Grocer Co., Little Rock, Ark.....	10,301.87	+ 32.50	10,334.37
4	Porter & Macrae, Memphis, Tenn.....	11,410.70	—228.65	11,182.05

* Recommended for acceptance. Contract entered into May 18, 1895; approved May 23, 1895; terminates March, 1896.

Abstract of bids for hardware and ship-chandlery supplies for improving Arkansas River, Arkansas, received in response to advertisement dated Mary 5, 1895, and opened May 21, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	Dudley E. Jones Co., Little Rock, Ark	$4,276.82	+$219.13	$4,495.95
2	Thomas, Barnes & Miller, Memphis, Tenn.*			
3	Dickinson Hardware Co., Little Rick, Ark	4,206.28	+ 1.72	4,208.00

* Bid incomplete and not signed.
† Recommended for acceptance. Contract entered into June 29, 1895; not yet approved; terminates March, 1896.

COMMERCIAL STATISTICS.

The steamboats report this year as being the worst for many years. From the reports rendered by them the table below is arranged showing the miles of river available for continuous navigation from the mouth up at different months in the year.

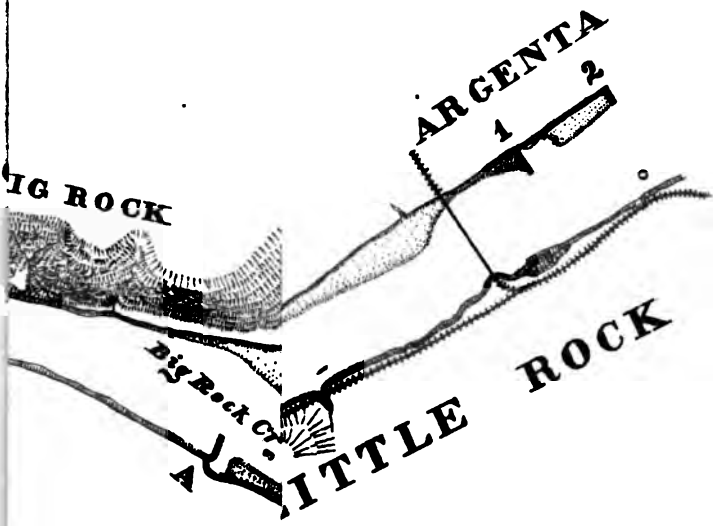
Dates—1894.	Head of navigation.	Miles.	Dates—1894-95.	Head of navigation.	Miles.
June 7 to July 9	Fort Gibson	463.2	Dec. 8 to Dec. 26	Dardanelle	260.7
July 10 to Aug. 5	Webbers Falls	429.2	Dec. 28 to Jan. 18	Douglass	61.1
Sept. 7 to Sept. 30	Webbers Falls	429.2	Mar. 7 to Apr. 20	Webbers Falls	429.2
Sept. 30 to Oct. 15	Bruce Island	379.7	Apr. 24 to May 19	Swan Lake	80.0
Oct. 20 to Dec. 8	Douglass	61.1	May 19 to June 4	Pendletons	40.6

August 5 to September 7, 1894, and January 18 to March 10, 1895, not reported. The head of navigation during this time was probably between Swan Lake and Pine Bluff.

List of steamboats engaged in navigating the Arkansas River, June 1, 1894, to May 31, 1895.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Ft. in.	*Ft. in.*			
Wm. Druhe No. 2*	Stern wheel	179.18	1 6	4 0	Fort Smith and Webbers Falls and intermediate points.	36	1,146
G. W. Mayo*	...do..	124.06	1 0	3 6	Fort Smith and Webbers Falls	4	492
					Fort Smith and Fort Gibson	1	
					Fort Smith and Redland	13	
					Fort Smith and Wilsons Rock	5	
					Fort Smith and Moores Rocks	2	
					Fort Smith and Shoal Creek	2	
					Fort Smith and Dardanelle	4	
New Mary Morgan.*	...do..	137.00	1 2	3 0	Little Rock and Dardanelle	17	85
					Little Rock and Petit Jean	1	8
Reese Pritchard	...do..	196.20	1 6	4 0	Little Rock and Pine Bluff; Little Rock and Morrison Bluff; Little Rock and Wilson Landing	14	50
U. K. Riggs*	...do..	122.38	1 9	3 0	Little Rock and Dardanelle	9	.....
					Little Rock and Pine Bluff	2	.....
					Little Rock and Silver Lake	2	.....
City of Little Rock.*	...do..	219.08	1 4	4 0	Little Rock and Dardanelle	17	404
					Little Rock and Carden Bottom	13	
					Little Rock and Ives Point	14	
					Little Rock and Pine Bluff	2	
					Little Rock and Cummings	2	
Border City*	...do..	88.86	1 4	3 0	Little Rock and Fourche	22	.....
					Little Rock and Ives Point	10	.....
Eli*	...do..	120.25	1 4	3 0	No report	(†)	(†)
Eugene	...do..	508.85	1 6	5 0	Memphis and Pine Bluff; Memphis and Swan Lake; Memphis and Douglass	30	966
Joe Peters	...do..	525.90	2 0	4 6	Memphis and Pine Bluff	(†)	(†)
L. E. Patton*	...do..	92.00	3 0	4 0	Memphis and Cummings	1	.....
Joy Patton*	...do..	67.00	3 6	4 0	.....do	1	.....
Luella Brown*	...do..	102.00	2 0	4 0	Greenville and Sandy Bayou	6	.....
Silvey	...do..				Helena and Cummings	(†)	(†)
Mud Hen	...do..	8.57	10		Pleasure boat		
Ariel	Screw.	9.34	4 0		Sand tug		

* With barges. † No report.



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Also the steamers *S. P. Pond, Viola,* and *Minnie Winters.* These boats were used for towing material used in improvement works. The tonnage transported by them is not included in the commerce of the river.

The steamer *Eli* sank January 5, 1895. The steamer *U. K. Riggs* came into this river October 13, 1894. There is a boat now constructing which when completed will be employed in the Memphis (Tenn.) and Pine Bluff trade.

Summary of commerce reported.

Articles.	Tons.		Articles.	Tons.	
	1895.	1894.		1895.	1894.
Cotton	4,274	7,213	Grain	1,992	3,185
Cotton seed	9,146	38,310	Miscellaneous freights	12,220	5,784
Hides and skins	12	31	Saw logs, by steamer	6,000	.....
Livestock	175	287	Saw logs, by rafts	11,400	1,240
Lumber	2,733	2,616			
Staves and bolts	513	250	Total	50,498	63,563
Provisions	2,033	4,647			

The Arkansas River is paralleled on the north side from Fort Gibson, Ind. T., to Swan Lake Landing, Arkansas, by the following railroads: Fort Gibson to Fort Smith, by the Kansas and Arkansas Valley; Fort Smith to Van Buren and Little Rock, by the Little Rock and Fort Smith Railway; Little Rock to Rob Roy, by the Little Rock Branch of the St. Louis Southwestern Railway; Rob Roy to Swan Lake Landing, by the Pine Bluff and Swan Lake Railway. At no point are these railroads over 12 miles from the river. On the south side of the river, from Little Rock to Douglas Landing, the Little Rock, Mississippi River and Texas Railway lies within 6 miles of the river. The river is crossed at Fort Smith by the Kansas and Arkansas Valley Railway; at Van Buren by the Texas Branch of the St. Louis and San Francisco Railway; at Little Rock by the St. Louis, Iron Mountain and Southern Railway, and by the Little Rock Junction Railway, and at Rob Roy by the St. Louis Southwestern Railway.

V 3.

IMPROVEMENT OF FOURCHE LE FEVRE RIVER, ARKANSAS.

The appropriation of March 3, 1879, was the first for the improvement of this river. This appropriation and the three succeeding ones were based on an examination made in December, 1878, report of which is in Annual Report Chief of Engineers, 1879, Part II, page 971.

The appropriation of August 5, 1886, was based upon a report made December 11 and 18, 1885, being the second and fourth indorsements on letter December 12, 1885, of Hon. John H. Rogers, M. C., Fourth district, Arkansas, to the Honorable Secretary of War. The appropriation of September 19, 1890, was based upon report printed in Annual Report Chief of Engineers, 1887, page 1533.

Original condition.—The obstructions were snags, overhanging timber, and a series of shoals.

Object of improvement.—Originally, to improve navigation from the mouth to Snyders Landing (56.5 miles). Later, to increase the length of the navigable season between Perryville and the mouth (27 miles).

Projects.—Originally, snagging operations and removal of rock in situ between the mouth and Snyders Landing. Project of 1886, to excavate channel through Alford Shoals. Project of 1890 (existing), to build a hand-propelled snag boat and operate it at lowest navigable stage between the mouth and Perryville; also to remove bowlders from Piney Shoals, excavate channel through May Shoals, and remove portion of Red Ferry Rock.

Work done in previous years.

Fiscal year.	Snags removed.	Trees cut.	Drifts destroyed.	Trees deadened.	Remarks.
1880	890	6,687			Between mouth and Perryville: Rocks removed from Kirks, Turner Rock, Red Ferry, Indian Grave, Piney Point, and May Shoals.
1881	53	2,045		3,508	Between Perryville and near Rock Creek: Two thousand two hundred yards dams built at shoals.
1882	476	685			Between mouth and Harrison Shoals: Temporary dams built at shoals.
1883	90	14,412		12,000	Between mouth and Harrison Shoals.
1887-88					Channel 1,500 feet long, 30 feet wide, 2 feet deep excavated through Alford Shoals.
1891					Snag boat *Pioneer* built.
1892	1,326	15,559	4	1,185	Between mouth and Perryville: Ninety cubic yards rock removed at Red Ferry Rock; 373 cubic yards rock and gravel removed from May Shoal, and 50 cubic yards rock removed from Piney Shoal; 510 cubic yards rock and gravel removed from landslides.

Operations of this fiscal year.—None.

Channel.—The work done on this river in fiscal year 1892 was reported as having opened the river to high and medium stage navigation to Perryville (27 miles above the mouth) and that the demands of commerce had been met. I have been unable to visit this stream.

Additional snagging operations will in time be required.

Commerce.—This river is the only available means for transporting crops and supplies, except by hauling in wagons to the Arkansas River and to the Little Rock and Fort Smith Railway, on the north side of the Arkansas. A bad bar at the conjunction of this river and the Arkansas River has very materially affected this year's commerce.

Even while there yet remained plenty of water in the Fourche Le Fevre River to permit light-draft boats to go to Perryville, a passage could not be made over the bar. About three months of this year three keel boats were run between Perryville and Little Rock, Ark., making a round trip a week, or about 24 single trips each. The amount of freight carried by these boats could not be learned by inquiry, but it is estimated at 1,000 tons, made up of cotton, corn, hides, and shingles as down freights and general store supplies as return trips.

APPROPRIATIONS AND EXPENDITURES.

The appropriations and expenditures for this stream have been as follows:

March 3, 1879	$10,000.00
June 14, 1880	4,000.00
March 3, 1881	3,000.00
August 2, 1882	4,000.00
August 5, 1886	5,000.00
September 19, 1890	7,500.00
	33,500.00
Received on account of sale of snag boat *Pioneer*	3,500.00
Total	37,000.00
Expended to June 30, 1894	35,579.96

Money statement.

July 1, 1894, balance unexpended	$1,420.04
June 30, 1895, amount expended during fiscal year	388.85
July 1, 1895, balance unexpended	1,031.19
July 1, 1895, outstanding liabilities	10.00
July 1, 1895, balance available	1,021.19

COMMERCIAL STATISTICS.

After August, 1894, Fourche Le Fevre River was reported navigable by light-draft boats to Perryville when the Signal Service gauge at Little Rock read over 4 feet. This gave navigable water over the bar at the mouth of Fourche Le Fevre twenty-nine days in September and October, 1894, ten days in January and February, 1895, and forty-two days in March and April, 1895. The steamer *Border City* (88.86 tons; draft, light, 16 inches; loaded, 36 inches) is the only steamboat which reports having been in the river since June 1, 1894. With barges it made 22 round trips from Little Rock to Perryville, 30 miles over the Arkansas River and 27 miles over the Fourche Le Fevre.

Summary of commerce reported June 1, 1894, to May 31, 1895.

Articles.	1895.	1894.	Articles.	1895.	1894.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Cotton	291	225	Grain	125	400
Cotton seed	477	213	Miscellaneous	156	260
Hides and skins	1	2	Keel boat freights	*1,000	(†)
Live stock	10	12	Saw logs by rafts	2,453	(†)
Lumber	200	25			
Provisions	.....	771	Total	4,714	1,908

*Estimated. †No report.

There are no competing lines of transportation. Wagon haul to the Arkansas River and to the Little Rock and Fort Smith Railway is the only means of transportation when the Fourche Le Fevre is not navigable.

V 4.

IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

The first appropriation for this river was that of August 5, 1886, and was based on an examination made in 1884, report of which is printed in Annual Report Chief of Engineers, 1885, page 1627.

Original condition.—The river was obstructed at all stages by drift, snags, and overhanging timber; at medium and low stages by rocky shoals.

Object.—Originally to render the river navigable at medium and high stages from the mouth to the town of Danville (45 miles). Later to prolong the season of navigation between the mouth and Rocky Crossing (20 miles).

Project.—Originally (1886) to clear the banks of overhanging timber and remove snags and drift. Later (1888) to remove small portions of Slaty Crossing and Robinsons Ridge shoals and remove timber from low-water channel.

Work done in previous years.—In the fiscal year 1887 very thorough work was done on the original project between the mouth and Rocky Crossing. In fiscal year 1891 the project of 1888 was completed. In fiscal year 1894 operations were continued on the original project, the work being confined to that portion of the river between Rocky Crossing and the town of Danville (25 miles), completing it as regards the conditions existing at that time, no results by snagging operations being more than temporary.

Operations during the fiscal year.—None.

Channel and commerce.—At the close of the fiscal year 1893 there was a channel 30 feet wide, clear of snags at such stage as to give 2 feet of water on the shoals. The bridge at Rocky Crossing is an absolute bar to steamboat navigation from Danville to the mouth. It has no draw, and, at a stage giving 2 feet of water on the rocky shoal above, has a clearance of little over 22 feet. I have not had funds or plant available for inspecting this stream during this year. Snags and overhanging timber are reported as again obstructing navigation below the Rocky Crossing Bridge and that the same, with drift piles in addition, obstruct rafting from points above.

The commerce to be benefited by improving this stream is carried on by small flats floated with the current and by rafting.

No complete statistics of it have been obtainable. Steamboats occasionally run up to Rocky Crossing.

APPROPRIATIONS.

The appropriations and expenditures for this work have been as follows:

August 5, 1886	$3,500.00
August 11, 1888	2,500.00
July 13, 1892	3,500.00
Total	9,500.00
Expended to June 30, 1894	9,314.34

Money statement.

July 1, 1894, balance unexpended	$185.66
June 30, 1895, amount expended during fiscal year	115.00
July 1, 1895, balance unexpended	70.66
July 1, 1895, outstanding liabilities	8.00
July 1, 1895, balance available	62.66

COMMERCIAL STATISTICS.

The steamer *New Mary Morgan* (67.62 tons) is the only steamboat which reports having been in the Petit Jean River since June 1, 1894. This boat made one trip to Rocky Crossing.

Summary of commerce reported June 1, 1894, to May 31, 1895.

Articles.	1895.	1894.
	Tons.	*Tons.*
Cotton	53.00	53.25
Hides and skins	.25	.40
Provisions		60.00
Miscellaneous freights	72.00	10.25
Saw logs, by rafts	1,133.00	(*)
Total	1,258.25	123.90

* No report.

Wagon haul to the Arkansas River is the only means of transportation when the river is not navigable.

V 5.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him, under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

OBJECT.

To secure and maintain a navigable channel of not less than 2 feet in depth at low water above Newport, and not less than 5 feet in depth at low water from Newport to the mouth.

PROJECT.

To remove snags and overhanging trees; to blast and dredge bowlders and rock or gravel reefs; to contract the channel where necessary by dams and spur dikes.

WORK DONE IN PREVIOUS YEARS.

Snagging operations, building wing dams, closing chutes, removing bowlders and rock reefs have been the operations on this stream in previous years. Reports of amount of rock and number of bowlders removed are not definite enough to enable one to give anything like an accurate report. The work done in construction of wing dams and the present condition of dams is given in one abstract; the snagging operations in another.

LIST OF DAMS BUILT, AND PRESENT CONDITION.

[The miles refer to distance above mouth of river.]

Summers Shoal (*405.4 miles*).—From right bank, one stone and brush wing dam 450 feet long, built in fiscal year 1882; repaired in fiscal year 1884. Present condition: Is broken in three places near center; about 375 feet remain; average height, 1 foot above low water.

Red Bud Shoal (*401.8 miles*).—One stone dam across right-hand chute, 268 feet long, built in fiscal year 1882. One stone wing dam, 140 feet long, built from left bank in fiscal year 1884. Present condition: Dam on right bank down to low water; only traces left of wing dam on left bank.

Crooked Creek Shoal (*396.8 to 397.8 miles*).—From left bank four stone wing dams, 775, 685, 160, and 185 feet long, built in fiscal year 1882. Present condition: The 775-foot dam almost gone; barely shows at low water. The 675-foot dam is gone, excepting the training wall, which is 250 feet long and about 2.5 feet above low water. The other two barely show at an 0.5 stage.

Buffalo Shoals (*390.3 to 391.5 miles*).—From right bank four stone wing dams, 300, 200, 300, and 175 feet. From left bank three stone wing dams, 275, 100, and 150 feet, built in fiscal years 1879 and 1880. Repaired in fiscal years 1884, 1886, 1890, and 1894. Present condition: The 275-foot dam on left bank is gone; the others are in fair condition. The original lengths are retained; the average height is 3.5 feet above low water.

The Rapides (*372.8 miles*).—Two stone dams, 240 and 500 feet, across chutes, built in fiscal year 1880. Present condition: The 240-foot dam is

broken in two places. The washouts are 20 and 30 feet each, washed to about 0.5 foot below low water; the remainder is about 1 foot above low water. The 500-foot dam is gone, excepting about 50 feet at shore end, which is 2 feet above low water.

Samms Island (*359.3 miles*).—One stone, gravel, and brush dam, 150 feet long, built across chute on left in fiscal year 1887. Present condition: Is about 125 feet long and barely shows at low water.

Samms Shoals (*357.8 miles*).—Two stone, gravel, and brush dams, 313 feet and 175 feet long, built across chutes on left in fiscal year 1881; rebuilt in fiscal year 1887. Present condition: The 175-foot dam is gone. Of the 313-foot dam 250 feet remain, at a height of 0.5 above low water; the rest is gone.

White House Shoals (*354.8 miles*).—Two stone, gravel, and brush wing dams, built in fiscal year 1887, one from the right bank 850 feet long, one from the left bank 710 feet long. Present condition: Both dams are down to low water and are nearly covered with sand and gravel.

Piney Creek (*353.6 miles*).—One stone wing dam, 418 feet long, built from left bank in fiscal year 1887. Present condition: Only 150 feet left and it is but 1 foot above low water.

Widemans Shoal (*352.3 miles*).—From left bank, one stone dam, 120 feet, and two stone, gravel, and brush dams, 120 and 60 feet, all across chutes, built in fiscal year 1887. Present condition: The 120-foot stone dam is in good condition and is 3 feet above low water. The 120-foot stone, gravel, and brush dam is washed down to low water, excepting 20 feet at shore end. The 60-foot dam is in good condition and is 2.5 feet above low water.

Fish Trap Shoals (*351.8 miles*).—One stone wing dam, 388 feet long, was built from left bank in fiscal year 1887. Present condition: Average height, 0.5 foot above low water.

Soldier Rock (*350.8 miles*).—One stone wing dam, 320 feet long, built from left bank in fiscal year 1887. Present condition: Gone.

Bone Island (*350.1 miles*).—One stone wing dam, 68 feet long, built in fiscal year 1887. Present condition: About 1 foot above low water.

Jeffreys Shoal (*347.1 miles*).—One stone wing dam, 290 feet long, built from left bank in fiscal year 1887. Present condition: Only a few traces left.

Rock Rapids (*346.4 miles*).—One stone wing dam, 173 feet long, built from left bank in fiscal year 1887. Present condition: Only 50 feet remain and that is only 0.5 foot above low water.

Perrins Shoal (*344.9 miles*).—Two stone wing dams, 192 feet long each. The one from left bank built in fiscal year 1886 and raised in fiscal year 1887; the one from right bank was built in fiscal year 1887. Present condition: Dam on left bank is about 1 foot above low water; the one on right bank is gone.

Harris Shoal (*344.1 miles*).—One stone wing dam, 140 feet long, from right bank, and one stone dam, 350 feet long, across chute from left bank, built in fiscal year 1887. Present condition: Wing dam on right bank gone. The dam across chute has one hole 40 feet wide washed out midway; also connection with the island is broken. About 200 feet of the dam remain at 3-foot stage.

Sylamore (*343.3 miles*).—One stone dam, 550 feet long, built across chute on left in fiscal year 1887. Present condition: Dam washed to about 0.5-foot stage and entirely covered with sand and gravel.

Round Bottom (*338.3 miles*).—Four stone wing dams, 56, 132, 300, and 136 feet, built from left bank in fiscal year 1887. Present condition: Barely a trace left of the 56-foot dam, nothing at all left of the 132-foot dam or the 136-foot dam. The 300-foot dam is down to 0.5-foot stage.

Wild Haws (331.1 miles).—Two gravel, stone, and brush wing dams—one from left bank 885 feet long, one from right bank 1,120 feet long—were built in fiscal year 1887. Present condition: There are a few traces of the dam on left bank. Of the one on right bank 500 feet remain at 2.5 stage. The other portion is down to low water.

McClellan's Ferry (319.8 miles).—One gravel and brush dam, 94 feet long, built across chute on left in 1887. Present condition: Badly damaged. About 50 feet remain at 2-foot stage.

Batesville Shoal (318.8 miles).—One brush and gravel dam, 294 feet long, built in fiscal year 1883; repaired in fiscal year 1887. Present condition: Part gone and part covered by sand and gravel.

O'Neal Shoal (316.5 miles).—Two stone and brush dams, 100 and 450 feet long, built across chutes on left in fiscal years 1885 and 1886. One wing dam on right, 47 feet long, built in fiscal year 1887. Present condition: The 100-foot dam is intact; the 450-foot dam washed down to 1-foot stage and is broken in two places, and only about 200 feet remain. The 47-foot dam is gone.

Eherenhardt's (310.1 miles).—Two brush and gravel dams—one from left bank, 448 feet; one from right bank, 512 feet—built in fiscal year 1885; repaired in fiscal year 1887. A stone wing dam 150 feet long, built on right bank in fiscal year 1887. Present condition: Barely a trace left of the 448-foot dam; the 512-foot dam is entirely gone; the 150-foot dam is in good condition and is 3 feet above low water.

Wyatts Shoal or Dark Corner (309.8 miles).—Two brush and gravel dams—one 462 feet long across chute on left, one 50 feet long across chute on right—built in fiscal years 1885 and 1886; repaired in fiscal years 1887 and 1890. Present condition: The 462-foot dam has two breaks, 25 and 30 feet each; only 300 feet of dam remain, and this is down to 0.5-foot stage. The 50-foot dam is in good condition; average height, 3 feet above low water.

Cornwall Shoal (305.8 miles).—One stone wing dam, 230 feet long, built from left bank in fiscal year 1892. Present condition: Only 100 feet remain, and that is down to low water.

Greenbriar Shoal (304.6 miles).—One stone, gravel, and brush wing dam, 520 feet long, built from right bank in fiscal year 1886; repaired in fiscal year 1887. Present condition: Is down to 0.6-foot stage.

Gillets Ford (302.8 miles).—One stone wing dam, 900 feet long, built from right bank in fiscal year 1891–92. This is known as "Batesville Dam." Present condition: In about as good condition as when completed; height is 6 feet above low water.

Cato Shoals (288.5 miles).—One stone wing dam, 285 feet long, built from right bank in fiscal year 1892. Present condition: Down to 0.6-foot stage.

Saffold Shoals (283.8 miles).—Two brush and gravel dams; total length, 1,250 feet; built in fiscal year 1882. One brush and stone wing dam, 175 feet long, built in fiscal year 1892 from right bank. Present condition: The 175-foot dam is covered by high bar. Those built in 1882 are either gone or covered by bar.

Haggletooth Shoals (269 miles).—Dams built across chutes in fiscal year 1882. One stone, gravel, and brush dam, 475 feet long, across chute on left, built in fiscal year 1892. Present condition: Of the dams built in 1882 there are no traces. The 475-foot dam is covered with gravel and sand.

Cleghorn Shoal (267.8 miles).—One brush and gravel dam, 687 feet long, built from left bank in fiscal year 1892. Present condition: Five hundred feet remain at 1-foot stage.

Rock Boat Shoal (265.8 miles).—One brush and gravel wing dam, 450 feet long, built from right bank in fiscal year 1892. Present condition: Average height, about 1.5 feet above low water.

Black Island (265.2 miles).—One brush and gravel wing dam, 286 feet long, built from right bank in fiscal year 1892. Present condition: Average height, 0.5 foot above low water.

Newport (257.8 miles).—One permeable dike, 145 feet long, built in fiscal years 1890 and 1892. Present condition: All of wattling and 35 feet of dike gone.

Near Aberdeen (90.3 miles).—Two riprap stone and brush dikes, each 125 feet long, built from right bank in fiscal year 1894.

Near St. Charles (65.8 miles).—Two stone and brush dikes, 100 feet each, built in fiscal year 1894.

Head of Little Island (38.3 miles).—Two stone and brush dikes, 100 feet each, built in fiscal year 1894.

There were 630 feet of brush and gravel dams built at Arnolds Island and Maguire Shoals in fiscal years 1881 and 1882. These are either gone or covered by sand and gravel.

Abstract of snagging operations fiscal years 1871 to 1894, inclusive.

Fiscal year.	Snags removed.	Trees cut.	Trees deadened.	Drift removed.	Remarks.
1871	235	.....	.....	.....	Between mouth and Des Arc.
1872	543	422	.....	3	Between mouth and Jacksonport.
1874	51	1,592	.....	1	Do.
1875	313	1,548	.....	5	Between Jacksonport and Buffalo Shoals.
1880	(?)	(?)	(?)	(?)	Between mouth and Jacksonport.
1881	270	298	.....	.....	Between mouth and De Valls Bluff.
	56	105	.....	.....	Between Jacksonport and Buffalo Shoals.
1882	905	4,319	.....	2	Between mouth and Wild Cat Shoal.
1883	404	2,859	.....	6	Between mouth and Buffalo Shoals.
1884	93	95	.....	1	Between mouth and (?)
1885	484	1,137	426	.....	Between Jacksonport and Buffalo Shoals.
1886	.....	1,399	50	.....	At Buffalo Shoals.
1887	166	2,014	101	6	Between Newport and mouth.
1888	20	.....	.....	.....	Between Clarendon and De Valls Bluff.
1889	131	27	.....	.....	Between Greenbriar and Indian Bay.
1890	28	8	.....	1	In Black Island Reach.
1891	12	.....	.....	1	Between Greenbriar and Maxwell's Gin.
1894	128	354	.....	.....	Between Batesville and head of Buffalo Shoals.

OPERATIONS OF THE FISCAL YEAR 1895.

The snag boat *Sheldon* began snagging operations at Tompkins Point, near the mouth of the river, on December 17, 1894, and worked up to Black Island Reach by January 7, 1895, when work was suspended on account of cold weather.

Excepting to make an inspection trip in April and transfer plant from Newport to Batesville in May, the boat did no work until June 14, when snagging operations were resumed.

Between this date and the close of the fiscal year the boat removed 10 snags that interfered with revetment work at Batesville, and worked from the foot of Black Island Reach to Haggletooth Shoal, 279 miles above the mouth. By these operations there were during the year 323 snags removed, 1,636 trees cut, and one drift pile broken up. Of the snags 77 were removed from Black Island Reach, a length of about 1.2 miles.

Batesville.—The work in progress at this place is that of protecting 2,310 feet of bank by revetment. The mattress used is 40 feet wide from water line out; the bank is paved with riprap stone to 20-foot stage. This work was commenced on June 7, and the mattress weav-

ing and bank grading completed on June 29; 2,350 feet of bank was graded, 2,310 feet of mattress woven and weighted, and 225 linear feet of bank riprapped complete; 461 cords of brush and 843 poles were used in the mattress. Up to the close of the fiscal year 650 cubic yards of stone have been delivered in the work. The material was purchased on ten days' circulars, brush, poles, and piling being delivered on Government barges at the work, the stone being delivered in place in the work.

PLANT.

Snag boat Sheldon.—Roof recanvassed, new nosing all around boiler deck and hurricane roof, cabin arranged to place entire crew on boiler deck, all bulkheading taken off main deck forward of engine room, new bed plate made for Providence capstan, hull calked above water line, and minor repairs made to machinery. Boat painted throughout.

Snag boat Riverside.—New shears; new deck and deck beams on forecastle; minor repairs to capstan; hull calked above water line.

Pile Driver.—New bed timber and hull stanchions; boiler fitted with 57 new flues; minor repairs to drum and engine; hull calked.

Quarterboat Albany and storeboat.—Hulls calked above water line and minor repairs.

Barges.—Hulls calked above water line; decks and rakes repaired.

CHANNEL.

The lower White River, viz, from the mouth to mouth of Black River and Jacksonport, 265 miles, is a remarkable stream, so far as its navigable capacity is concerned. Boats drawing from 3½ to 4 feet can generally navigate this reach of river the entire year. In some years a few places shoal up so as to reduce the low-water depths slightly; this is not an annual occurrence, but is due to some unusual conditions. The banks are generally low and the course is very sinuous, the current sluggish.

White River, above the mouth of Black River, is ordinarily termed Upper White River. Its characteristics are entirely different from Lower White, the available low-water depths being about 17 inches between Jacksonport and Batesville (37.2 miles). Above Batesville the depths get as small as 8 and 10 inches. The slope of Upper White is about double that of Lower White. The valley is alluvial for about 20 miles above the mouth of Black River, and from there up the river assumes more and more the characteristics of a mountain stream. The shoals are composed of gravel, gravel and bowlders, and sometimes solid rock.

An attempt has been made to improve this stream by means of wing dams, constructed at the worst shoals, but the testimony of the steamboat men is that the navigation season, for a reach of river sufficiently long to constitute "a trade" for a steamboat, has not been lengthened. The current during high water becomes so swift in this portion of the stream that it is difficult to maintain wing dams, and as a result the greater part of those dams already constructed has been carried out altogether or washed down to low-water level.

COMMERCE.

The commerce of the upper White River centers at Newport and Batesville. It is carried on by light-draft boats which carry one or more barges when freights require it. These full loadad, with barges, are from 50 to 250 tons.

From Batesville to Jacksonport the White River is paralleled on the left bank by the Diaz and Batesville branch of the St. Louis, Iron Mountain and Southern Railway; from Jacksonport to Newport it is paralleled by White and Black River Valley Railway, also on the left bank. Three miles below Newport it is crossed by the main line of the St. Louis, Iron Mountain and Southern Railway. This railroad lies within 12 miles of the river (on the right bank) to Augusta. On the left bank, between Newport and Augusta, the White and Black River Valley Railway lies within an average distance of 9 miles.

Near Augusta the river is crossed by the Bald Knob and Memphis branch of the St. Louis, Iron Mountain and Southern Railway, and near Devalls Bluff by the Little Rock and Memphis Railway; at Clarendon, by the St. Louis Southwestern Railway.

V 6.

IMPROVEMENT OF CACHE RIVER, ARKANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

To comply with requirements of river and harbor act approved August 5, 1886, an examination was made of this stream. Upon the report of this examination the first appropriation (August 11, 1888) was based.

Original condition.—Upper reaches in many places entirely blocked by drifts at all stages below extreme high water. The lower reaches badly choked by fallen timber. Natural depths decreased by sunken logs and trees.

Object of improvement.—To improve navigation at medium and high stages from the mouth to Riverside (102 miles).

Project.—To remove the obstructions by operating light-draft snag boat.

Work done in previous years.—During fiscal year 1889 the hand-propelled snag boat *Riverside* was built and 3 miles of river below the town of Riverside cleared of the main obstructions. In fiscal year 1890 this work was continued to Walkers Ferry (12 miles below Riverside).

In fiscal year 1893 the river was thoroughly worked at about the 6-foot stage from the mouth to Gregory Branch Railway Bridge (86 miles). Operations in fiscal year 1894 were confined to opening a channel 50 feet wide through the timber blown into the river by the storm of June 30, 1893. This work extended from Gregory Branch Railway Bridge to Kalachi (46 miles above the mouth).

Operations of this fiscal year.—None.

Channel.—The portion of river between Riverside and Gregory Branch Railway Bridge is again badly obstructed by drifts and fallen timber. Below this bridge fallen timber narrows the channel to Kalachi. Below Kalachi there is a fair channel at 4-foot stage and over.

Commerce.—No steamers ply this river at present. Its commerce consists of rafting, of which there has been little this year. A large quantity of timber was cut during the winter, but lack of high water prevented rafting it. Much of the timber taken out of this river goes to New Orleans for export. Of this quantity no information could be obtained upon inquiry.

The Little Rock and Memphis Railway Bridge at Old Boyds Landing is an obstruction to through steamboat navigation, and is represented to be the cause of steamboats leaving this river.

APPROPRIATIONS.

The appropriations and expenditures for this work are as follows:

August 11, 1888	$7,000.00
July 13, 1892	2,000.00
	9,000.00
Received on account of sale of snag boat *Riverside*	2,000.00
Total	11,000.00
Expended to June 30, 1894	10,887.99

Money statement.

July 1, 1894, balance unexpended	$112.01
June 30, 1895, amount expended during fiscal year	12.01
July 1, 1895, balance unexpended	100.00
July 1, 1895, outstanding liabilities	4.00
July 1, 1895, balance available	96.00

COMMERCIAL STATISTICS.

Rafting was the only commerce reported. The amounts given are reported as being about one-half the average, this on account of continued low water. Planters above the Little Rock and Memphis Railway Bridge will probably place a small steamboat in the river sometime during the coming winter, this boat to run between the railway bridge and James Ferry (Gages Point)—about 48 miles.

Commerce reported.

	Tons.
Saw logs, by rafts	12,150
Railway ties, by rafts	417
Saw logs, by flatboat	36
Total	12,603

This river is crossed at Riverside by the White and Black River Valley Railway; at 4 miles below Riverside by the Bald Knob and Memphis branch of the St. Louis, Iron Mountain and Southern Railway, and at 7 miles above James Ferry by the Gregory branch of the White and Black River Valley Railway. Between Riverside and Yorks Landing it is paralleled on the east by the White and Black River Valley Railway, the greatest distance apart being about 6 miles.

V 7.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him, under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

The first independent appropriation for this river was made by act of Congress approved June 14, 1880, and the report for that fiscal year implies that the appropriation was based upon report of an examination provided for by act of Congress approved March 3, 1879. (Annual Report Chief of Engineers, 1880, Part II, p. 1326.)

Original condition.—The general obstructions to navigation were shoals, snags, logs, and leaning timber. The first 31 miles below Poplar Bluff was a mass of snags and leaning trees.

Abstract of bids for subsistence supplies for improving Black River, Arkansas and Missouri, received in response to advertisement dated March 28, 1895, and opened April 18, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	James E. Joyce & Co., Little Rock, Ark	$587.99	—$7.72	$580.27
2	H. J. George & Co., Little Rock, Ark	527.62	+ 7.09	*534.71
3	The Chas. F. Penzel Grocer Co., Little Rock, Ark	551.57	+ 2.31	553.88
4	Porter & Macrae, Memphis, Tenn	604.34	— 2.69	601.65

*Recommended for acceptance. Contract entered into 18th day of May; approved May 23, 1895; terminates March, 1896.

COMMERCIAL STATISTICS.

The river was reported navigable to Poplar Bluff during nine months. Duck Roost was reported blocked at low water.

List of boats engaged in navigating Black River, Arkansas and Missouri, June 1, 1894, to May 31, 1895.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between.	Round trips.	Passengers.
			Ft. in.	Ft. in.			
Ada*	Screw.	4	2 11	3 9	Towing timber to Poplar Bluff	115	150
Moark*	Stern-wheel.	27.33	1 4	2 0	do	40	200
Krata*	do		1 6		Towing ties to Black Rock		
Portia*	do	49.60	1 6	3 0	Pocahontas to Strawberry	104	704
A. R. Bragg	do	162.71	1 6	3 6	Mouth of Black and mouth of Current.	52	1130
					Mouth of Black and Birds Point.	30	

*With barges.

The steamer *Rambler* left this river in November, 1894. The Steamer *Krata* began navigating it September 1, 1894.

Summary of commerce reported.

Articles.	1895.	1894.	Articles.	1895.	1894.
	Tons.	Tons.		Tons.	Tons.
Cotton	1,473	2,545	Saw logs, by steamer	3,200	
Cotton seed	6,320	1,524	Lumber, by flatboat	200	
Hides and skins	96	19	Saw logs, by raft	80,731	39,300
Live stock	57	59	Railroad ties, by steamer	5,108	
Lumber	12,640	9,710	Railroad ties, by raft	8,333	12,375
Staves and bolts	8,171	17,412	Piling, by raft	400	
Provisions	2,694	632	Square timber, by raft	1,500	
Grain	495	372			
Miscellaneous freights	578	1,808	Total	132,433	87,536
Spokes	437	1,780			

Distribution of commerce reported.

Between points on—	Tons.
Black River and Poplar Bluff	15,381
Black River and Moark, Corning, and Knobel	32,600
Black River and Black Rock	31,603
Current River* and Black Rock	21,513
Black River and Newport	23,553
Current River† and Newport	7,783
Total	132,433

*38 miles on Black River. †146 miles on Black River.

Sixty-eight and seven-tenths per cent of the commerce reported is rafted.

The Black River is crossed at Poplar Bluff, Mo., by the Poplar Bluff and Cairo branch of the St. Louis, Iron Mountain and Southern Railway; near Corning, Ark., by the main line of the St. Louis, Iron Mountain and Southern Railway; at Black Rock by the main line Kansas City, Fort Scott and Memphis Railway, and near Paroquette Bluff by the Diaz and Batesville Branch of the St. Louis, Iron Mountain and Southern Railway. From Poplar Bluff, Mo., to the mouth the river is paralleled by the main line of the St. Louis, Iron Mountain and Southern Railway. The greatest distance apart is about 12 miles.

V 8.

IMPROVEMENT OF CURRENT RIVER, ARKANSAS AND MISSOURI.

The appropriation of August 17, 1894, was based upon a report made to comply with the requirements of the river and harbor act of September 19, 1890. The report was printed in House Ex. Doc. No. 157, Fifty-first Congress, second session, and in Annual Report Chief of Engineers for 1891, pages 2065–2071.

Original condition.—Between the mouth and 2 miles below the State line, snags and overhanging timber were the obstructions to navigation; above this point gravel shoals were added to the list.

Object.—To improve the navigation of the river from the mouth to Van Buren, Mo. (95 miles).

Project.—To remove logs and snags from channel; to cut and deaden overhanging timber, and to contract water width at worst shoals by wing dams.

Work done in previous years.—In 1855 the State of Missouri appropriated $10,000 for the improvement of this stream. The first expenditure was in 1857, when some snags were removed and some timber cut. In 1872 another State appropriation ($20,000) was expended in building wing dams, removing snags, and cutting timber.

The first work done by the United States was in 1873, and was confined to reaches above the Arkansas and Missouri State line. It consisted of removing snags and cutting timber, building new and repairing old wing dams. Subsequent operations below the State line in fiscal years 1882 and 1883 were confined to the usual snagging operations. No further work was done until the present appropriation became available.

Abstract of work done by the United States.

Fiscal year.	Snags removed.	Trees cut.	Dams built.	Remarks.
			Linear ft.	
1873	123	592		Above Arkansas and Missouri State line.
			629	At Kittrick's Mill.
			86	Shore protection at Kittrick's Mill.
			325	At Doniphan Shoal.
1882	180	300		Between mouth and Little Black River Cut-off (32 miles).
1883	85			Between mouth and Shumachers Landing (23½ miles).

Operations during this fiscal year.—The hand-propelled snag boat *Riverside* was towed from Black Rock, on Black River, to the mouth of Current River on October 6, 1894, and began operations the same day. After working four times over the river between the mouth and Jim

Johnson's (25 miles) the snag boat left the river on February 23, 1895. Five hundred and eighty-two snags were removed and 698 trees cut.

Channel.—The portion of the river above Jim Johnson's I have been unable to visit. Below this point the river is in good condition, and can be navigated the entire year by boats of not over 3½ feet draft.

Commerce.—During this fiscal year the Black and Current River Packet Company have run out of Newport, Ark., a weekly packet to Jim Johnson's all the year, and in high water to points above. Sometime in 1893 parties at Doniphan, Mo. (53 miles above the mouth), made an effort to navigate the river above that point, and the *Fleetwood* (length, 50 feet; beam, 12 feet; draft, 12 inches) is said to have gone 45 miles up the river from there. In 1894 the *Current* (length, 40 feet; beam, 8 feet; draft, 14 inches) was built at Doniphan. The machinery proved defective on the trial trip, and the boat has been dismantled. The *Fleetwood* has not been run in the last twenty months. Throughout the entire river large quantities of timber are rafted.

APPROPRIATIONS.

The early examinations of this river were made under appropriations for this in combination with other streams. The independent appropriations for this stream are as follows:

June 2, 1872, Current River, Missouri	$5,000
March 3, 1881, Current River, Arkansas and Missouri	2,000
August 17, 1894, Current River, Arkansas and Missouri	8,000
Total	15,000
Expended prior to June 30, 1894	7,000

Money statement.

Amount appropriated by act of August 17, 1894		$8,000.00
Received on account of deposit made by First Lieut. William L. Sibert		2.00
		8,002.00
June 30, 1895, amount expended during fiscal year		3,559.89
July 1, 1895, balance unexpended		4,442.11
July 1, 1895, outstanding liabilities	$165.00	
July 1, 1895, amount covered by uncompleted contracts	855.32	
		1,020.32
July 1, 1895, balance available		3,421.79

Amount (estimated) required for the completion of existing project	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of bids for subsistence supplies for improving Current River, Arkansas and Missouri, received in response to advertisement dated March 28, 1895, and opened April 18, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	James E. Joyce & Co., Little Rock, Ark	$931.77	−$7.72	$924.05
2	H. J. George & Co., Little Rock, Ark	855.32	+ 8.09	*863 41
3	The Chas. F. Pentzel Grocer Co., Little Rock, Ark	877.49	+ 2.30	879.79
4	Porter & Macrae, Memphis, Tenn	956.96	− 5.03	951.93

*Lowest bid; recommended for acceptance. Contract entered into 18th day of May; approved May 23, 1895; terminates March, 1896.

Abstract of bids for hardware and ship-chandlery supplies for improving Current River, Arkansas and Missouri, received in response to advertisement dated May 5, 1895, and opened May 21, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	Dudley E. Jones Co., Little Rock, Ark.*	$1,561.80	+$39.56	$1,601.36
2	Dickinson Hardware Co., Little Rock, Ark	1,536.67	+ 91.81	1,628.48

*Recommended for acceptance. Contract entered into June 29, 1895; not yet approved.

COMMERCIAL STATISTICS.

The steamer *A. R. Bragg* (162.7 tons; draft, light, 18 inches; draft, loaded, 42 inches) is the only boat which reports having been in this river during the year. Running out of Newport, Ark., 7 miles over White River and 146 over Black River, this boat made forty-five round trips to Johnsons Landing (25 miles above the mouth) and seven round trips to Richards (37 miles above the mouth).

Summary of commerce reported June 1, 1894, to May 31, 1895.

Articles.	Tons.	Articles.	Tons.
Cotton	875	Spokes	437
Cotton seed	550	Saw logs, by rafts	13,479
Lumber, by steamer	960	Railroad ties, by rafts	8,333
Lumber, by flatboats	66	Square timber, by rafts	1,500
Staves and bolts	4,225	Fence posts, by rafts	44
Provisions	540		
Grain	175	Total	31,205
Miscellaneous freights	21		

The Current River Railway, from Willow Springs, Mo., to Grandin, Mo., crosses the Current River 3 miles below Van Buren, Mo. This road lies on the bank of the river from near the town of Van Buren to Grassy Creek. Three miles east of this point it has a connection with the Cape Girardeau and Fort Smith Railway, giving a railroad connection with the Mississippi River at Cape Girardeau.

The western terminus of the Doniphan Branch of the St. Louis, Iron Mountain and Southern Railway is at Doniphan. Below this point and to the east the main line of the St. Louis, Iron Mountain and Southern Railway lies at a distance varying from 20 to 10 miles.

V 9.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

Original condition.—Below Marked Tree snags, leaning trees, and shoals obstructed navigation. Above Marked Tree, through the Sunk Lands, the channel meandered through cypress brakes, beds of smartweed, and in many places the waters were divided by sloughs and chutes.

Object of improvement.—Originally to improve navigation below Lesters Landing (232 miles), later to extend improvement (73 miles) to the town of St. Francis, Ark., now to improve navigation between Kennett, Mo., and the mouth of the river (279 miles).

Project.—The usual snagging operations and closing of chutes and sloughs.

Work done in previous years.—Work done on this stream has been under the heads of improvement of White and St. Francis rivers and that of improving St. Francis River, Arkansas. The abstract below contains that done under both heads, excepting closing of sloughs and chutes.

Abstract of work done.

Fiscal year.	Snags removed.	Trees cut.	Trees deadened.	Drifts removed.	Remarks.
1872	431	151	.....	2	Worked from mouth up to (?).
1874	36	76	.....	.....	Between mouth and Wittsburg.
1880	130	1,201	.....	11	Between Madison and Little River.
1881	*259	523	.....	.....	In Lower Reaches.
	*1,655	1,294	697	.....	Between Lesters Landing and Wittsburg.
1882	*363	.....	.....	.....	Between mouth and Wittsburg.
1883	562	866	.....	3	Between Wittsburg and Cut-off.
1885	88	2,993	.....	.....	Between mouth and Madison.
	196	653	.....	.....	Between Wittsburg and foot of Sunk Lands Lake.
1886	1,961	1,863	.....	4	Between foot of lake and town of St. Francis.
1887	195	4	.....	.....	Between L'Anguille River and Madison.
	621	210	.....	.....	Between Marked Tree and St. Francis.
1888	31	24	.....	.....	Near head of Dunklin Co. Cut-off.
1889	*47	.....	.....	1	Between Kennett and St. Francis.
1890	.....	.....	.....	.....	New hull built for A. B. Johnson.
1891	69	48	.....	.....	Between St. Francis and mouth of Little River.
1892	205	.....	.....	.....	Between Madison and Cut-off.
1893	1,046	446	.....	9	Between Madison and mouth.
1894	770	5,298	.....	1	Between Madison and Marked Tree.

* Includes snags, logs, stumps, and cypress knees.

Operations during this fiscal year.—September 24, 1894, to January 26, 1895, operating between Madison, Ark., and the mouth of the river (70 miles) with hand-propelled snag boat *A. B. Johnson;* 524 snags and 1 drift pile were removed and 2,321 trees cut.

On the trip from Madison down to the mouth of the river the stage of water was favorable for removing low-water obstructions. The *Johnson*, draft 15 inches, was pulled over Quigly Crossing (65 miles above the mouth) and over Fords Bar (23 miles above the mouth). Returning, the boat was laid up at Park Place from November 12 to December 27, because of only 10 inches of water over Ford Bar.

After December 27 operations were continued, working toward Madison, the river rising slowly all the time. Between Overcup Bend and Madison (12 miles) the river was at a stage that prevented any work on the low-water snags.

May 27, 1895, to June 30, 1895, operating between foot of lake (199 miles above mouth) and Griffy Island (255 miles above mouth), with the hand-propelled snag boat *Missouri;* 441 snags, logs, and stumps were removed. Of these 19 were removed between foot of lake and Mangrums Landing, 23 miles; 22 between Lake City and The Scatters, 7 miles; 360 in The Scatters, 1¾ miles, and 40 between The Scatters and Griffy Island, 20½ miles.

Channel.—The portion of the river between Madison, Ark., and 10 miles above Marked Tree, Ark., I saw from the U. S. towboat *Cleveland* when the river was at 3.1 stage by the Madison gauge. The banks of this part of the stream are quite permanent. The channel is somewhat obstructed by snags at the above stage and at lower stages navigation is seriously interfered with.

Below Madison the governing bar is the Ford (23 miles above the mouth). Between Wittsburg and Madison, Muscle Bar (90 miles above the mouth) controls draft of boats. A draft that can be taken over this bar can go to Tyronza, 38 miles above.

That portion of the St. Francis River between 10 miles above Marked Tree, Ark., and Kennett, Mo., known as the Sunk Lands, I have been unable to visit. The snag boat *Missouri* operated over a portion of this during the year and between the Foot of Lake and Lesters Landing reported a well-defined channel, 50 to 200 feet wide, from 3 to 8 feet deep at a stage said to be 2 feet above extreme low water and 3 feet below ordinary high water, the banks just about flush with the water surface.

About 1 mile above Lesters Landing is what is known as "The Scatters. Here there are three chutes, the middle one of which (1¾ miles long) has the greatest depth of water. The boat was sixteen days working through this chute; 12 inches of water was the available depth. Above The Scatters at Little Island was a bed of smartweed for nearly a mile and a half; three days were spent in getting through this. The depth of water here was from 2 to 5 feet. From Little Island to within 3 miles of Bolins Ferry 9 miles gave water depths of 5 to 12 feet, and 3 miles gave depths of 2 to 3 feet.

Commerce.—At Marked Tree are large sawmill interests which obtain their material from 15 to 20 miles below as well as from above. The greater part of the material used at these mills is represented as coming out of Little River, passing over 6 miles of the St. Francis River. In the Sunk Lands there is some commerce between Lake City and Bolins Ferry, the crossing of the Paragould Southeastern Railway. On the lower river, the Lee Line out of Memphis supplies the demands of commerce; excepting that during high water Mississippi River towboats run up the river a short distance for timber. Above Bolins Ferry there is no commercial navigation, but the building of the Paragould Southeastern Railway may develop some.

APPROPRIATIONS.

The early examinations and the earlier operations were made under appropriations for this in conjunction with other rivers. Of the expenditures under those appropriations this office has no record.

The separate appropriations are as follows:

March 3, 1871	$10,000.00	September 19, 1890	$4,000.00
June 14, 1880	5,000.00	August 17, 1894	*83,000.00
July 5, 1884	12,000.00		
August 5, 1886	8,000.00	Total	126,000.00
August 11, 1888	4,000.00	Expended to June 30, 1894	42,547.59

Money statement.

July 1, 1894, balance unexpended		$452.57
Amount appropriated by act of August 17, 1894		8,000.00
		8,452.57
June 30, 1895, amount expended during fiscal year		3,138.13
July 1, 1895, balance unexpended		5,314.44
July 1, 1895, outstanding liabilities	$921.35	
July 1, 1895, amount covered by uncompleted contracts	856.27	
		1,777.62
July 1, 1895, balance available		3,536.82

Amount (estimated) required for work annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

*Seventy-five thousand dollars of this, by the conditions of the act, to be expended by the Mississippi River Commission.

Abstract of bids for subsistence supplies for improvement of St. Francis River, Arkansas, received in response to advertisement dated March 28, 1895, and opened April 18, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	James E Joyce & Co., Little Rock, Ark	$931.77	−$7.72	$924.05
2	H. J. George & Co., Little Rock, Ark	856.27	+ 7.10	*863.37
3	The Chas. F. Penzel Grocer Co., Little Rock, Ark	877.49	+ 2.30	879.79
4	Porter & Macrae, Memphis, Tenn	953.36	− 2.56	950.80

* Recommended for acceptance. Contract entered into May 18, 1895; approved May 23, 1895; terminates March, 1896.

Abstract of bids for hardware and ship-chandlery supplies for improvement of St. Francis River, Arkansas, received in response to advertisement dated May 5, 1895, and opened May 21, 1895.

No.	Name and address of bidder.	Total as per bid.	Correction.	Total.
1	Dudley E. Jones Co., Little Rock, Ark	$1,448.72	+$170.40	$1,619.12
*2	Dickinson Hardware Co., Little Rock, Ark	1,598.37	− 12.48	1,585.89

* Recommended for acceptance. Contract entered into June 29, 1895; not yet approved.

COMMERCIAL STATISTICS.

Fords Bar (23 miles above the mouth) was the head of low-water navigation. Lesters Landing, 232 miles above the mouth, was the head of navigation at medium stages. No navigation was reported above Bolins Ferry, 258 miles above the mouth.

List of steamboats engaged in navigating St. Francis River, Arkansas, June 1, 1894, to May 31, 1895.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between.	Round trip.	Passengers.
			Ft. in.	*Ft. in.*			
Ike*	Stern-wheel.	66.19	1 6	2 2	Mangrums and Marked Tree	6	.....
					Marked Tree and Bradshaw	5	.....
Rambler*	...do	22.07	1 10	3 0	Not given	.....	.....
Steamer Colla*	...do	10	2 0	3 0	...do	.....	.....
J. W. Peters*	...do	12	1 8	2 6	...do	.....	.....
Delta*	...do	45	1 5	2 6	Lake City and Bolins Ferry; Wittsburg and Madison.	.....	.....
Tom Young*	...do	15	1 5	2 4	Marked Tree and Bolins Ferry	3	.....
Clarence E. Long*	...do	.....	.....	.....	No report	.....	.....
Lola*	...do	.....	.....	.....	...do	.....	.....
Louis Houck*	...do	.....	.....	.....	Partial report	.....	.....
Ora Lee	...do	189.34	2 0	5 0	Memphis and Wittsburg	18	407

* With barges.

Summary of commerce reported.

Articles.	1895.	1894.	Articles.	1895.	1894.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Cotton	382	125	Staves by flatboats	300	.....
Cotton seed	1,172	60	Grain	734	43
Hides	10	2	Miscellaneous freights	1,023	1
Live stock	61	45	Saw logs by rafts	5,000	12,000
Lumber by steamboats	4,585	575	Saw logs by flatboats	1,000	.....
Lumber by rafts	.....	1,000	Saw logs by steamboats*	16,000	.....
Provisions	271	52			
Staves by steamboats	7,569	5,860	Total	38,107	19,763

* By Mississippi River towboats.

V 10.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

This work was under the charge of Capt. Carl F. Palfrey, Corps of Engineers, until August 15, 1894, when I relieved him under Special Orders, No. 179, paragraph 17, Adjutant-General's Office, series of 1894.

The first appropriation under this head was based upon report of an examination made to comply with the requirements of river and harbor act, August 5, 1888. This report is printed in the Annual Report of the Chief of Engineers for 1887, page 1549.

Original condition.—Channel obstructed by snags, drifts, drift shoals, and overhanging timber. In the upper reaches by gravel shoals.

Object of improvement.—Originally to improve navigation between the towns of St. Francis, Ark., and Greenville, Mo. (102 miles). Later to include the river from St. Francis, Ark., down to Kennett, Mo. (26 miles), in this improvement.

Project.—The usual snagging operations.

Work done in previous years.—Although the original estimate and the basis for the first appropriation contemplated removal of gravel from the shoals lying within 12 miles of Greenville, this work was never included in the projects for expending the various appropriations, thus leaving snagging operations as the work of past years.

Abstract of work done.

Fiscal year.	Snags destroyed.	Drifts removed.	Trees cut.	Remarks.
1889.....	216	.....	50	Between St. Francis and Greenville. Channel 600 feet long opened through Big Drift.
1890.....	309	4	175	Between Pollards Ferry and St. Francis. Channel through Big Drift reopened.
1891.....	.....	.....	.....	Hand snag boat Missouri built.
1892.....	1,423	15	5,405	Between St. Francis and Big Drift.
1893.....	346	79	1,097	Between Big Drift and Kennett. Channel through Big Drift reopened.

Operations this fiscal year.—Other than transferring the hand-propelled snag boat from Little Rock, Ark., to the lower end of the Sunk Lands nothing was done.

Commerce.—The commerce of this river is that arising solely from lumber and stave industries, and centers mainly at the town of St. Francis.

The logs are rafted from points above, the other material is transported in barges of 70 to 80 tons capacity, handled by steamers drawing not over 2½ feet.

Channel.—The channel is narrow and seriously obstructed by snags, logs, and overhanging timber. From Chalk Bluff to the Dunklin County Cut-off (25 miles) there would probably be 2 feet of water at low water for ten months in the year if the river was thoroughly cleared. Above Chalk Bluff the river can only be navigated at medium and high stages of water.

APPROPRIATIONS AND EXPENDITURES.

This reach of river is understood not to have been included in the snagging operations under the early appropriations for snagging in Western rivers.

From James Ferry to the mouth, a distance of 79 miles, the channel of the river is well defined, having a low-water width of about 130 feet, the depth of water on the controlling shoals being from 18 to 20 inches. In extreme low water the depth on the controlling shoals gets as small as 12 inches. This, however, is a rare occurrence.

The obstructions to navigation in this part of the stream are snags, drifts, overhanging timber, and shoals.

The removal of the snags, overhanging timber, and drifts would render available to navigation all the water found in the stream, viz, a depth of 18 to 20 inches, in ordinary low water.

The prospective commerce of the stream would not, in my opinion, justify an attempt to increase these low-water depths.

No steamboats attempt now to navigate this stream. The Little Rock and Memphis Railway Bridge is an obstruction to through navigation. If the river was thoroughly cleaned there might be business for a few months in the year for a steamboat between the above bridge and James Ferry.

There is a scope of finely timbered country bordering Cache River, and with an improved river this timber could be profitably placed on the market. After the timber is exhausted agricultural pursuits will probably increase and make commerce.

In my opinion Cache River is worthy of improvement by the usual snagging operations from the mouth to James Ferry, a distance of 79 miles. In my opinion a survey of Cache River is not necessary to the preparation of a project and estimate of cost of improvement proposed.

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieut. of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, August 22, 1895.

Respectfully forwarded to the Chief of Engineers, United States Army.

For the reasons stated within I concur with Lieutenant Sibert in the opinion that Cache River is worthy of improvement by the United States to the extent of clearing the channel of snags, etc., for a distance of 79 miles from its mouth. It is also stated that a survey is not necessary to the preparation of a project and estimate of cost of improvement proposed.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. P. R. VAN FRANK, ASSISTANT ENGINEER.

MAY 27, 1895.

SIR: I compliance with verbal orders I have the honor to make the following report of Cache River:

At the time of the examination the river was from 3 to 4 feet above low water, therefore the low-water depths and widths are from hearsay evidence.

From Riverside to one-half mile above Grays Bridge the river varies greatly in width, sometimes being about 130 feet wide, and again not over 40 feet wide. The average width is probably about 80 feet. The wide places are more in the nature of lakes than of river, having very little current at 3-foot stage and none at low

water. The narrow places are the connections between the lakes, and have good current at 3-foot stage. The depth of water in the lakes is good, averaging, as it does, about 6 feet at low water. But in the connections between the lakes the low-water depth gets as small as 8 inches, with a low-water width of 20 to 40 feet. There are nine such places in this reach of 7¼ miles, but as three of these lie within one-eighth of a mile, they might be considered as one, making the shoals that have less than 1 foot of water six in number. These lake connections are, as a rule, very crooked as well as narrow, at one place making a complete S within 300 feet. The Bald Knob Branch of the St. Louis, Iron Mountain and Southern Railway crosses this reach 4 miles below Riverside with a pile bridge, bents 14 feet apart, and at nine places the river is entirely blocked with fallen timber and drift; at many other places nearly so.

At one-half mile above Grays Bridge a better river is found, the low-water width being about 135 feet, with a depth not less than 8 feet and the bends easy. This continues for a distance of 2 miles, at which point the river divides at what is called "The Prongs." The smaller of "The Prongs" has a low-water depth of about 6 inches and low-water width of about 8 feet; the larger, a depth of about 10 inches and low-water width of about 20 feet. Below "The Prongs" there are about 2 miles of wide river, when it again is very crooked, irregular in widths and depths, to the vicinity of the Gregory Branch Bridge of the White and Black River Valley Railway. From this point down the river is freer of drift and overhanging timber, and from Bayou Cache to the mouth the river is more uniform in width, the bends much easier, and the pools are longer, being from 4 to 10 miles in length. In this reach of about 76 miles there are four shoals that have an ordinary low-water depth of 18 to 20 inches and a low-water width of about 130 feet. In extreme low waters these get as low as 12 inches, but this is a rare occurrence.

The banks throughout the river are low, being from 3 to 5 feet above low water between Riverside and Grays Bridge; 5 to 7 feet above low water between Grays Bridge and Bayou Cache, and from 10 to 14 feet above low water from Holly Ridge to the mouth of the river. There are exceptions to these heights at places where the river touches the high ground bordering the bottom. The overflow begins to fill the bottom at a stage 4 feet above low water in the vicinity of Riverside. This line gradually rises until it obtains a height of about 10 feet in the vicinity of Fort Mayberry, from which point to the mouth there is very little increase in its height. The bottom and average overflow width varies from three-fourths to one and one-half miles between Riverside and Gregory Branch Bridge; from Bayou Cache to the mouth it varies all the way from 5 to 10 miles, an average width being about 7 miles. Above Bayou Cache the difference between high and low water is about 12 feet. Below this point the high waters of Cache are affected by those of White River, the high waters of the latter finding a partial outlet into Cache River through the bayou. At Mayberry the difference is about 18 feet, which is about the difference until below the Little Rock and Memphis Railroad Bridge, where it sometimes reaches a height of 25 feet, due to the backwater from White River.

The lands bordering on Cache Bottom are very fertile, and before the extension and consolidation of the railway systems depended upon this river for means of transportation, and for a number of years three boats were regularly in this trade, running up to Grays on ordinary high water, and to Gages Point on medium stages. The Little Rock and Memphis Railroad caused the boats to withdraw from the Memphis run, after which a small steamer was run between the Little Rock and Memphis Bridge and the head of navigation.

This boat passed out of existence when the White and Black River Valley Railroad and the Bald Knob Branch of the Iron Mountain and Southern were completed. Of late years the river has been used for rafting purposes, but now, on account of the long wagon haul from some of the principal plantations and high freight rates, there is being an effort made to get another boat in the river. The business of this boat will be confined mostly to the transportation of sawmill products, but it is estimated that from the eight old steamboat landings between Bayou Cache and the Little Rock and Memphis Railroad 1,800 bales of cotton and 900 tons of seed will also be handled as outgoing freights. The incoming freights would probably be of small amount, consisting of supplies for timber camps and two or three plantations. With an improved river the outgoing timber business would probably be quite large, as there is a scope of heavily timbered country (17 miles wide by 36 miles long, air line measurements) depending upon this river for transportation.

Between Riverside and James Ferry the river, in my opinion, is not worthy of improvement further than that for rafting at high stages, which continue about three months each year. It is not at all probable that plantation products would seek river transportation between these points, as the plantations are in close touch with two lines of railways.

Below James Ferry (79 miles above the mouth) it is more difficult to reach the only railroad paralleling the Cache River. Ordinary low waters give a controlling depth

of 18 to 20 inches for about three months during the year; the banks are stable and the obstructions (excepting the four shoals before mentioned) are removable by ordinary snagging operations. It is my opinion that timber interests alone warrant these operations, having in view the improvement of navigation at ordinary low water, and that depths sufficient for eight to nine months' navigation each year will be procured thereby. * * *

The Little Rock and Memphis Railway Bridge (31 miles above the mouth) is an obstruction to through navigation. It has in it a 30-foot drift span, a clear height above ordinary high water of about 4 feet, and a clear height above extreme low water of 26.6 feet. The railway company has in times past lifted this span to permit the passage of boats, but this has always been accompanied with a delay of from two to three days.

There has been very little rafting on the river during this year, on account of the continued low water. There is a large amount of timber now down ready for rafting, but it was impracticable to get the amount. Large quantities of timber from this river are rafted to New Orleans. Of this no report is obtainable. So far as could be accurately obtained 11,200 tons of saw logs and 417 tons of railroad ties is the amount of rafting done within the last year.

I have the honor to be, very respectfully, your obedient servant,

P. R. VAN FRANK, Jr.,
Assistant Engineer.

First Lieut. WM. L. SIBERT,
Corps of Engineers, U. S. A.

V 13.

PRELIMINARY EXAMINATION OF ST. FRANCIS RIVER, FROM THE SUNK LANDS TO GREENVILLE, MISSOURI.

UNITED STATES ENGINEER OFFICE,
Mount Nebo, Ark., July 27, 1895.

SIR: I have the honor to submit the following report on examination of St. Francis River from the Sunk Lands to Greenville, Mo., made in accordance with river and harbor act of August 17, 1894.

Examinations were made of this stream in 1873 and 1881. The report on the examination made in 1873 will be found in the Annual Report of the Chief of Engineers for that year, page 477. The report on the examination made in 1881 will be found in the Annual Report of the Chief of Engineers for that year, page 1481. Both of these are detailed reports, and since the conditions are practically the same as they were then, except that some snags and drifts have been removed, rendering navigation more easy at medium and high stages of water, it was not deemed necessary to examine the entire stream. Such an examination would have been merely a duplication of records.

The details as to the source, course, and varying widths of the stream are recorded in the reports referred to above.

I made an examination of that part of the stream from Chalk Bluff to near the Dunklin County Cut-off, a distance of about 25 miles. This examination was made when the water was at a low stage, thus enabling me to see a characteristic stretch of the river when navigation was most interfered with.

Kennett Landing is ordinarily considered the head of the Sunk Lands. From there to Greenville, Mo., is 128 miles. The obstructions to navigation are snags, drifts, overhanging timber, and shoals.

In my opinion the commerce to be developed on this stream would not justify any attempt at improvement other than that made by the usual snagging operations. If all the snags, etc., were removed from Chalk Bluff to the head of the Sunk Lands (28 miles) and the river confined to one channel, there would, in my opinion, in ordinary seasons,

be a low-water depth of 2 feet available for navigation. Considerable business can be done on that depth with the small boats and barges in use in this stream.

From Chalk Bluff to Poplin, Mo., a distance of 56 miles, there is some commerce, principally the transportation of timber by boats and in rafts, at medium and high stages of water. Above Poplin, Mo., there is some rafting. The commerce of this stream for the last fiscal year was 23,326 tons, principally timber in its various forms. In my opinion St. Francis River above the Sunk Lands is worthy of the following improvements:

To thoroughly clear the river of snags, drifts, and overhanging timber from the head of the Sunk Lands to Chalk Bluff, 28 miles, and to confine the river to one channel. To remove those snags, drifts, and overhanging timber that would interfere with navigation at medium and high stages from Chalk Bluff to Poplin, Mo., a distance of 56 miles.

In my opinion, a survey of that portion of St. Francis River under consideration is not necessary to the preparation of a project and estimate of cost of improvement proposed.

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieut. of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. H. M. Robert, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, August 22, 1895.

Respectfully forwarded to the Chief of Engineers, U. S. Army.

For the reasons stated within I concur in the opinion of Lieutenant Sibert, that the St. Francis River, above the Sunk Lands, is worthy of improvement by the United States, to the extent of clearing the channel of snags, etc., as far as Poplin, Mo.

It is also stated that a survey is not necessary to the preparation of a project and estimate of cost of improvement proposed.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

APPENDIX W.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MO., AND OF KASKASKIA RIVER, ILLINOIS.

REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between Ohio and Missouri rivers.
3. Harbor at St. Louis, Mo.
4. Kaskaskia River, Illinois.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 6, 1895.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

W 1.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

Before this work was inaugurated the navigation of the river was very much interfered with by numerous snags, logs, etc., which had lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks, dangerous to navigation, also occupied the channel. For the removal of these obstructions appropriations were made as early as 1824, and the project adopted consisted of building boats suitable for removing the snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given, as, previous to the appropriations made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required.

Congress, by act of March 3, 1879, appropriated the first specific sum for removing snags, wrecks, etc., from the Mississippi River, and that appropriation was followed by others until 1888, when, by the act of August 11 of that year, an annual expenditure not to exceed $100,000 for this purpose was authorized. Under that act operations have since been carried on annually.

The two snag boats, the *H. G. Wright* and the *J. N. Macomb*, after undergoing some minor repairs during the spring of 1894, proceeded upon their annual work of removing obstructions. The *Wright*, under command of Capt. R. E. Birch, commenced work on July 21, 1894, and operated continuously between the mouth of the Missouri River and Memphis, Tenn., until March last, when, having thoroughly removed obstructions in that extent of river, it returned to St. Louis, from which point it proceeded, April 8, to Mound City, where it was docked in order to have its hull replated, a contract for that work, to be completed on or before August 1, 1895, having been made with the Iowa Iron Works, of Dubuque, Iowa. The contract was dated March 13, 1895.

The *Macomb*, under command of Capt. A. H. Stewart, began work July 12, 1894, and operated continuously between Memphis and Bayou Sara, Louisiana, thoroughly clearing the channel of obstructions to navigation. The *Macomb* returned to St. Louis March 14, 1895, and then proceeded to lay up at Bushberg, Mo., for overhauling and minor repairs.

The *Wright* was built in 1880, and the *Macomb* in 1874. They were both designed and built by Major (now Lieutenant-Colonel) Suter, of the Corps of Engineers. The following general description of the *Macomb* and of its method of operating will answer for both boats, the *Wright* only differing from the *Macomb* in having the benefit of some improvements suggested by experience.

The boat is of iron, 178 feet long and 90 feet wide over wheel guards; it has twin bows separated by an open space 12 feet wide, called a well, which extends 65 feet aft from the stems. The speed of the boat is 8½ miles per hour in still water with engines of 600 horsepower. A steel butting beam 22 feet long, 7 feet wide, and 16 inches thick spans the space between the bows near the stems at the surface of the water. The end of a snag is lifted onto this beam by means of a sweep chain which is hung as a loop from one stem to the other, or by means of tackle hung from sheer poles which stand over the beam like the letter A. Four steam capstans, each capable of a direct pull of 35 tons and a speed of 30 feet per minute, supply the power for operating the appliances and also for pulling the snag in its inclined position upon the beam. To aid in this there is added a powerful purchase fitted with a cast-iron drum, winding a chain with links made of iron 2¼ inches in diameter. This chain is tested at 75 tons, but is often broken in the work to which it is subjected. The combined pulling power of this purchase and the four capstans is 215 tons; but this is quite insignificant when compared with the work accomplished by butting, using the whole boat as a hammer of 800 tons weight. The snag being drawn upon the beam and an after roller, which also bridges the well, it is sawn into logs by powerful steam saws, one working over the roller and one over the forward edge of the butting beam. The after saw reduces the body of the tree to logs that are dropped anywhere, as they will float away, but the large root, matted with clay and gravel and sometimes 20 feet in diameter by 3 or 4 feet thick, is carefully dropped into some deep hole or a place well out of the channel of the river.

In cases of great difficulty the hydraulic jet and dynamite are occasionally employed as auxiliaries in loosening the root of the snag.

The amount of work accomplished by the two boats during the past fiscal year is given in the following table:

Name of snag boat.	Snags pulled.	Leaning trees cut.	Drift piles removed.	Wrecks removed.	Miles run.
H. G. Wright	1,365	10,666	8	3	6,895
J. N. Macomb	1,942	6,854	14	.....	9,507
Total	3,307	17,520	22	3	16,402

The wrecks which were removed by the *Wright* are as follows:

At Island No. 40.—A coal barge was entirely removed from the channel by dynamite and the aid of a diver, January 3 to 9, 1895.

At Cape Girardeau.—The wreck of the steamer *Albert S. Willis* was removed from the channel March 17 to 20, 1895; the boilers and most of the machinery were recovered and brought to St. Louis.

At St. Genevieve.—A barge belonging to the Southern Lumber and Transportation Company, which was sunk and abandoned by the steamer *Polar Wave*, was partially destroyed and the parts dangerous to navigation removed March 23, 1895.

The trees referred to are generally leaning timber in bends of the river, or trees that are liable to fall into the stream and become obstructions.

An annual appropriation of an amount not to exceed $100,000 having been made for the work, the snag boats will patrol the river whenever necessary, in order to keep the channel free from obstructions such as snags, logs, drift piles, leaning trees, and such small wrecks as they may occasionally be enabled to handle. The removal of large, heavy, or numerous wrecks by the snag boats is not contemplated, the boats not being built for such purpose or for wrecking. The removal of wrecks from the channels in general is provided for by a specific act of Congress.

Amount expended on this work to July 1, 1894, under all specific and annual appropriations, including that of March, 1879, $1,019,010.46.

Amount expended on the work during the fiscal year ending June 30, 1895, $78,270.52, a detailed statement of which expenditure is given in the accompanying Tables Nos. 1 and 2. This work was all done by hired labor.

The work accomplished by the snag boats is of great benefit to the navigation of the river. Formerly the sinking of steamboats by running on snags was of frequent occurrence, but since the snag boats have been regularly at work such wrecks are seldom heard of.

It is proposed during the coming fiscal year to continue the work of the snag boats, as provided for in the act of 1888.

During the past fiscal year several boats were damaged or sunk on the river between the mouth of the Missouri and Bayou Sara, Louisiana, especially during the extreme low-water season of 1894, but they either struck sand bars, or rolling stumps, or obstructions other than snags.

For statistics of commerce benefited by the snag-boat operations reference must be made to the statistics of the Mississippi River from the mouth of the Missouri River to New Orleans.

For an account of the work of replating and repairing the hull of the *H. G. Wright*, attention is invited to the report herewith of First Lieut. Chester Harding, Corps of Engineers.

Appropriations made by Congress for removing obstructions in Mississippi River.

By act of—		For fiscal year ending—	
March 3, 1879	$100,000.00	June 30, 1890†	$49,089.17
June 14, 1880	100,000.00	June 30, 1891	92,720.97
March 3, 1881	80,000.00	June 30, 1892	98,250.00
March 2, 1882	85,000.00	June 30, 1893	96,497.23
July 5, 1884*	72,950.63	June 30, 1894	88,252.46
August 5, 1886	56,250.00	June 30, 1895	100,000.00
August 11, 1888	100,000.00		
		Total	1,119,010.46

The headquarters of the snag boats is in St. Louis, which is the nearest port of entry and which is in the collection district of New Orleans.

The amount of customs collected at St. Louis during the fiscal year was $1,197,346.70.

The amount of internal revenue collected was $7,388,503.13.

Money statement.

Amount to be drawn under section 7, act of August 11, 1888		$100,000.00
June 30, 1895, amount expended during fiscal year		78,270.52
June 30, 1895, outstanding liabilities	$4,054.45	
June 30, 1895, amount covered by uncompleted contracts‡	17,675.03	
		21,729.48
July 1, 1895, amount available for fiscal year 1895–96		100,000.00

Abstract of proposals for replating U. S. snag boat H. G. Wright, received in response to advertisement dated January 21, 1895, and opened February 20, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Amount.
1	Iowa Iron Works, Dubuque, Iowa	$22,900
2	Cincinnati Marine Railway, Cincinnati, Ohio	23,300

No seals to signatures of guarantors of bid No. 1.

No seals to signatures of bidders of bid No. 2.

Bid No. 1, lowest, acceptance recommended.

Amount available, $22,900, from the continuous annual appropriation of $100,000 made by act of August 11, 1888.

*This appropriation was for $75,000, $72,950.67 of which was used on this work.

†Section 7, act of August 11, 1888, provides for a yearly appropriation of $100,000, or as much thereof as may be necessary, for the purpose of removing snags, wrecks, and other obstructions from the Mississippi River.

‡The contract for replating the U. S. snag boat *H. G. Wright*, amounting to $22,900, will be paid partly from this year's appropriation and partly from the appropriation for fiscal year 1895–96.

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River during fiscal year 1895, as required by section 7 of the river and harbor act of August 11, 1888.*

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1894.				
July...	66	Western Union Telegraph Co	Telegrams	$0.48
	108	Chas. J. Allen, major, Corps of Engineers.	Mileage	4.00
	116	Hired men	Services	1,681.69
	117	....do	....do	276.66
	118	....do	....do	553.00
Aug...	7	....do	....do	1,635.33
	8	....do	....do	101.84
	22	Chester Harding, lieutenant, Corps of Engineers.	Mileage	12.00
	24	E. E. Furney	Services	100.00
	26	E. J. Spencer	Electric-light plant	967.69
	56	Anchor Line Store	Outfit and supplies	18.41
	57	Gust. Bischoff	Subsistence	223.75
	58	R. Bush	....do	5.20
	59	M. M. Buck & Co	Copper, etc	13.70
	60	Big Muddy Coal and Iron Co	Coal	107.00
	61	Cairo City Coal Co	....do	102.50
	62	Consolidated Coal Co. of St. Louis	....do	6.50
	63	Crown Coal and Tow Co	....do	81.00
	64	H. L. Fox & Co	Manila rope, etc	235.96
	65	Henry A. Koettker	Subsistence	173.94
	66	Chas. Kney	....do	28.44
	67	John Lowell	....do	51.64
	68	Matt Monaghan & Co	....do	55.05
	69	G. E. Meissner	....do	12.65
	70	J. S. Merrell Drug Co	Medicines	27.90
	71	Newcomb Bros. Wall Paper Co	Molding	6.00
	72	Peter Nicholson & Sons	Subsistence	73.75
	73	David Nicholson	....do	75.79
	74	Page & Tolkacz	Stovepipe, etc	12.50
	75	Robt. D. Patterson Stationery Co	Stationery	2.85
	76	Pittsburg Coal Co	Coal	330.00
	77	St. Louis Electrical Supply Co	Lamp shades, etc	8.25
	78	J. D. Streett & Co	Oil	27.56
	79	Simmons Hardware Co	Chain, etc	1.18
	80	Schulz Belting Co	Leather belt	41.58
	81	Scarritt Furniture Co	Mattresses	2.94
	82	E. B. Stowe & Co	Subsistence	645.84
	83	Ward Bros	....do	27.37
	84	James Ward & Son	Supplies	45.81
	85	Whitelaw Bros	White lead, etc	27.50
	86	The Albert Webb Supply Co	Iron pipe	3.57
	87	Wrought Iron Range Co	Castings	16.00
	88	Western Iron and Supply Co	Gas pipe dies	1.13
	89	Chester Harding, second lieutenant, Corps of Engineers.	Mileage	43.28
	90	....do	....do	10.80
	91	Excelsior Manufacturing Co	Castings	8.30
	92	Huse & Loomis Ice and Transportation Co.	Ice	49.00
	94	Jos. Hirsch	Subsistence	20.00
	95	L. S. Koerber	....do	44.45
	96	Oscar Setz	....do	14.50
	97	Natchez Ice Co	Ice, etc	23.00
	98	Peatross, Cameron & Co	Coal	70.00
	99	Thos. Sexton & Co	Outfit	5.20
	103	Hired men	Services	300.00
	104	....do	....do	1,771.00
	105	....do	....do	398.00
	107	....do	....do	1,855.00
	108	....do	....do	346.00
Sept...	6	St. Louis and New Orleans Anchor Line	Freight charges	9.76
	54	Anchor Line Store	Chain	8.78
	55	M. M. Buck & Co	Outfit	8.20
	56	Gust. Bischoff	Subsistence	100.55
	57	Big Muddy Coal and Iron Co	Coal	172.50
	58	Cairo City Coal Co	....do	278.40
	59	Consolidated Coal Co. of St. Louis	....do	165.00
	60	Crown Coal and Tow Co	....do	70.00
	61	Samuel Cupples Woodenware Co	Rope	161.69
	62	J. H. Coffin & Co	Outfit and supplies	36.36
	63	Geo. G. Fairham & Bro	Subsistence	8.75
	64	Jos. Hirsch	....do	81.28
	65	Huse & Loomis Ice and Transportation Co.	Ice	55.41
	66	Henry A. Koettker	Subsistence	63.85
	67	Chas. Kney	....do	37.38
	68	L. S. Koerber	....do	37.22
	69	Matt Monaghan & Co	....do	159.12

TABLE NO. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1894.				
Sept...	70	Peter Nicholson & Sons	Subsistence	$46.66
	71	N. O. Nelson Manufacturing Co	Gardner governor	12.00
	72	Natchez Ice Co	Ice	26.00
	73	Pittsburg Coal Co	Coal	832.50
	74	Valentine Resch	Subsistence	74.65
	75	Scarritt Furniture Co	Repairing furniture	40.25
	76	Smith Torrence	Material and labor	20.00
	77	Evander Williams & Co	Subsistence	35.10
	78	Walter & Co	....do	76.72
	79	Chester Harding, second lieutenant, Corps of Engineers.	Mileage	21.64
Oct....	2	Hired men	Services	353.00
	3	....do	....do	1,860.00
	4	....do	....do	330.00
	5	....do	....do	1,820.00
	6	....do	....do	360.00
	69	E. J. Spencer	Labor and material	11.50
	70	Peatross, Cameron & Co	Coal	402.50
	71	James A. Tappan	....do	227.50
	72	Chickasaw Iron Works	Castings, etc	73.85
	95	Western Union Telegraph Co	Telegrams	6.89
	96	Cairo City Coal Co	Coal	231.20
	97	Walter & Co	Subsistence	53.69
	98	Valentine Resch	....do	47.40
	121	Hired men	Services	1,796.00
	122	....do	....do	366.00
	123	....do	....do	300.00
Nov ...	1	....do	....do	1,850.00
	2	....do	....do	340.00
	35	Chester Harding, second lieutenant, Corps of Engineers.	Mileage	39.88
	129	Anchor Line store	Brushes, rope, etc	78.10
	130	Berton & Werner	Subsistence	16.10
	131	Big Muddy Coal and Iron Co	Coal	37.50
	132	M. M. Buck & Co	Files, packing, etc	46.40
	133	Baldwin, Knowlton & Lake	Subsistence	89.48
	134	J. H. Coffin & Co	Rope, boots, etc	183.27
	135	D. Crawford & Co	Cotton batting	4.25
	136	Samuel Cupples Woodenware Co	Brooms, brushes, etc	6.83
	137	Consolidated Coal Co. of St. Louis	Coal	67.50
	138	Drey & Kahn	Glass	1.75
	139	Ewald Iron Co	Iron	14.37
	140	Flachman & Matthews	Oil, paint, etc	20.03
	141	Geo. G. Fairham & Bro	Subsistence	30.35
	142	Glidden Varnish Co	Asphaltum	2.50
	143	Jos. Hirsch	Subsistence	27.73
	144	Horn & Co	....do	8.85
	145	Huse & Loomis Ice and Transportation Co.	Ice	11.00
	146	J. F. Irvine & Son	Coal	75.00
	147	L. S. Koerber	Subsistence	62.25
	148	Chas. Kney	....do	97.73
	149	Leonard & Ellis	Dynamo oil	6.00
	150	Matt Monaghan & Co	Subsistence, etc	277.00
	151	Meyer Bros. Drug Co	Medicines	21.67
	152	A. Moll Grocer Co	Subsistence	50.58
	153	Natchez Ice Co	Ice and milk	39.75
	154	National Tube Works Co	Ells	.76
	155	The Oliver-Finnie Grocer Co	Subsistence	288.52
	156	Paddock-Hawley Iron Co	Files and iron	34.86
	157	Peatross, Cameron & Co	Coal	168.00
	158	Pittsburg Coal Co	....do	954.00
	159	L. M. Rumsey Manufacturing Co	Steam fittings	16.84
	160	Schoelhorn-Albrecht Machine Co	Cast-iron chocks	12.37
	161	Schroeter Bros	Lumber	7.92
	162	Simmons Hardware Co	Hardware, etc	3.74
	163	Jas. A. Tappan	Coal	360.50
	164	James Ward & Son	Brooms, turpentine, etc	34.43
	168	W. C. Postal	Coal	17.20
	213	Hired Men	Services	353.00
Dec....	1	....do	....do	1,790.00
	2	....do	....do	383.00
	11	....do	....do	1,841.50
	12	....do	....do	347.50
	14	Chas. B. Zeigler	Traveling expenses	27.20
	25	Chester Harding, second lieutenant, Corps of Engineers.	Mileage	55.78
	110	Gust. Bischoff	Subsistence	220.50
	111	Big Muddy Coal and Iron Co	Coal	129.50
	112	Cairo City Coal Co	....do	88.00

TABLE NO. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1894.				
Dec....	113	J. H. Coffin & Co	Iron, etc	$17.55
	114	Crown Coal and Tow Co	Coal	252.54
	115	George G. Fairham & Bro	Subsistence	50.57
	116	Heckel Hardware Co	Strainers, etc	.85
	117	Jos. Hirsch	Subsistence	62.18
	118	Huse & Loomis Ice and Transportation Co.	Ice	20.81
	119	Kupferle Bros. Manufacturing Co	Whistle valves	10.00
	120	Chas. Kney	Subsistence	42.42
	121	L. S. Koerber	do	28.35
	122	Lee Bros	Sponges, etc	10.75
	123	Matt Monaghan & Co	Subsistence	148.52
	124	Peter Nicholson & Sons Grocer Co	do	152.58
	125	David Nicholson	do	167.88
	126	Natchez Ice Co	Ice, etc	8.50
	127	Peatross, Cameron & Co	Coal	267.75
	128	Pittsburg Coal Co	do	652.50
	129	Ranken & Fritsch Foundry and Machine Co.	Brass liner	25.00
	130	Valentine Resch	Subsistence	20.90
	131	E. B. Stowe & Co	do	102.31
	132	James A. Tappan	Coal	211.40
	133	E. H. Warner & Son	Lumber	47.52
	134	Western Iron and Supply Co	Iron and rivets	14.24
	135	J. V. F. Walker	Subsistence	5.20
	136	Walter & Co	do	37.03
	137	Western Electrical Supply Co	Carbons, etc	47.25
	158	Western Union Telegraph Co	Telegrams	4.23
	160	Hired men	Services	300.00
	163	do	do	1,841.33
	164	do	do	358.67
	165	do	do	1,820.00
	166	do	do	356.00
1895.				
Jan....	8	H. L. Fox & Co	Boots, mops, etc	19.10
	17	Western Union Telegraph Co	Telegrams	3.38
	20	John T. Guyre	Services as diver	108.75
	69	Anchor Line Store	Brooms, subsistence, etc	154.19
	70	Big Muddy Coal and Iron Co	Coal	135.12
	71	A. G. Brauer	Stove casting	1.75
	72	Alois Boschert & Co	Subsistence	69.89
	73	Henry Bruck	do	91.66
	74	Berton & Werner	do	45.30
	75	Baldwin, Knowlton & Lake	do	6.95
	76	Cairo City Coal Co	Coal	343.00
	77	Consolidated Coal Co. of St. Louis	do	72.00
	78	Crown Coal and Tow Co	do	84.00
	79	Samuel Cupples Woodenware Co	Brushes	4.45
	80	Chicago and Texas R. R. Co	Repairs	6.00
	81	J. H. Coffin & Co	Boots, brushes, etc	76.35
	82	Drey & Kahn	Glass	4.70
	83	M. Dougherty	Subsistence	105.45
	84	Dean & Carroll	Sponges, etc	8.55
	85	Ewald Iron Co	Iron and steel	6.89
	86	Fly & Hobson	Subsistence	5.90
	87	Galloway Coal Co	Coal	7.00
	88	Heckel Hardware Co	Axes, etc	7.17
	89	James M. Houston Grocer Co	Subsistence	83.82
	90	Loyd G. Harris Manufacturing Co	Lumber	29.29
	91	Jos. Hirsch	Subsistence	16.94
	92	Henry A. Koettker	do	9.65
	93	Chas. Kney	do	101.94
	94	L. S. Koerber	do	38.75
	95	Leonard & Ellis	Boiler compound	36.30
	96	Matt Monaghan & Co	Subsistence	246.47
	97	The Oliver-Finnie Grocer Co	do	323.50
	98	Paddock-Hawley Iron Co	Iron	23.05
	99	Pittsburg Coal Co	Coal	896.25
	100	Ringen Stove Co	Stove castings	9.00
	101	H. B. Robinson	Subsistence	18.35
	102	J. D. Streett & Co	Oils	4.20
	103	Simmons Hardware Co	Planes, etc	7.08
	104	Seessel & Ashner	Subsistence	10.80
	105	Solomon, Johnson & Brady	do	8.38
	106	Jas. A. Tappan	Coal	315.00
	107	Walter & Co	Subsistence	91.42
	108	do	do	53.86
	109	James Ward & Son	Brushes	12.00
	110	Whitelaw Bros	White lead, etc	31.98
	111	Peatross, Cameron & Co	Coal	227.50
	115	Hired men	Services	353.00

TABLE No. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1895.				
Jan....	116	Hired men	Services	$1,850.00
	117	.....do	.....do	310.00
	118	.....do	.....do	1,865.00
	119	.....do	.....do	325.00
Feb....	9	Western Union Telegraph Co	Telegrams	2.26
	61	Anchor Line Store	Water cooler, etc	32.68
	62	Brinckley Lumber Co	Lumber	4.26
	63	Berton & Werner	Subsistence	28.85
	64	Alois Boschert & Co	.....do	64.85
	65	Chas. W. Barstow	Paints and oils	44.16
	66	Big Muddy Coal and Iron Co	Coal	66.75
	67	Cairo City Coal Co	.....do	244.00
	68	The Consolidated Coal Co. of St. Louis	.....do	157.00
	69	J. H. Coffin & Co	Mops, oil, etc	153.68
	70	Dean & Carroll	Varnish, sponges, etc	14.72
	71	Ewald Iron Co	Steel	13.97
	72	Fly & Hobson	Subsistence	40.23
	73	Henry A. Koettker	.....do	23.85
	74	L. S. Koerber	.....do	37.90
	75	Lee Bros	Boots, brooms, etc	36.85
	76	Matt Monaghan & Co	Subsistence	223.98
	77	The Oliver-Finnie Grocer Co	.....do	280.98
	78	Pittsburg Coal Co	Coal	944.50
	79	Petross, Cameron & Co	.....do	184.80
	80	Perterson & Homes	Basin	2.10
	81	The Phœnix Powder Manufacturing Co	Dynamite	12.00
	82	John Rohan & Sons Boiler Works Co	Labor and material	30.76
	83	Valentine Resch	Subsistence	81.25
	84	Seessel & Ashner	.....do	3.58
	85	E. B. Stowe & Co	.....do	144.01
	86	Simmons Hardware Co	Stove boards	4.00
	87	St. Louis Iron and Machine Works	Tiller heads	37.00
	88	Jas. A. Tappan	Coal	194.25
	89	Wrought Iron Range Co	Castings	1.10
	90	James Ward & Son	Siphons, etc	46.80
	91	Western Electrical Supply Co	Electric switches	3.90
	92	Western Iron and Supply Co	Flanged tees	15.23
	93	Evander Williams & Co	Subsistence	263.30
	94	Walter & Co	.....do	115.68
	95	John A. Haynes, attorney in fact of G. D. Williamson.	.....do	6.00
	96	.....do	.....do	24.25
	99	Buxton & Skinner Stationery Co	Job printing	24.23
	142	Baldwin, Knowlton & Lake	Subsistence	71.62
	143	Berton & Werner	.....do	41.95
	144	Commercial Electrical Supply Co	Globes	4.90
	145	Cairo City Coal Co	Coal	144.00
	146	J. H. Coffin & Co	Calipers, dusters, etc	59.83
	147	Cahill, Collins & Co	Hose, etc	131.38
	148	L. S. Koerber	Subsistence	99.96
	149	Lee Bros	Dynamite	66.00
	150	Matt Monaghan & Co	Subsistence	140.55
	151	The Oliver-Finnie Grocer Co	.....do	241.57
	152	Pittsburg Coal Co	Coal	1,000.50
	153	Paddock-Hawley Iron Co	Iron	11.53
	154	Peatross, Cameron & Co	Coal	364.00
	155	Jas. A. Tappan	.....do	315.00
	156	Walter & Co	Subsistence	76.63
	157	John A. Haynes, attorney in fact of G. D. Williamson.	.....do	14.20
	158	Evander Williams & Co	.....do	127.83
	160	Chester Harding, first lieutenant, Corps of Engineers.	Mileage	20.62
	163	Hired men	Services	1,850.00
	164	.....do	.....do	317.00
	165	.....do	.....do	300.00
	167	Victor H. Poss	.....do	100.00
	169	Hired men	.....do	995.00
	170	.....do	.....do	1,175.00
Mar ...	6	Wm. Jones	.....do	8.00
	12	Thomas Somers	Wood	12.37
	13	J. T. Reed	.....do	27.00
	14	H. C. Amberg	Subsistence	17.28
	15	W. B. Ward's Sons	.....do	50.32
	16	J. R. McClure	.....do	36.05
	17	B. L. Welker	Coal	48.41
	18	Western Union Telegraph Co	Telegrams	2.87
	26	Geo. Knapp & Co	Advertising	9.60
	27	Pulitzer Publishing Co	.....do	7.77
	28	John R. McLean	.....do	6.00

TABLE No. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1895.				
Mar ...	29	The Post Printing and Publishing Co....	Advertising	$8.40
	30	The Engineering Record.....	.....do	4.80
	31	Shipping and Commercial List Co.....	.....do	6.00
	32	Chester Harding, first lieutenant, Corps of Engineers.	Mileage.....	10.80
	33	Ed. Hanson	Services	20.00
	70	A. G. Brauer.....	Stove grate	1.00
	71	Berton & Werner.....	Subsistence	62.90
	72	Commercial Electrical Supply Co.....	Incandescent lamps, etc	12.60
	73	J. H. Coffin & Co.....	Leather belt	4.10
	74	Cairo City Coal Co	Coal	109.00
	75	H. M. Ehrman.....	Subsistence.....	67.53
	76	Jos. Hirsch.....	.....do	19.19
	77	L. S. Koerber.....	.....do	46.66
	78	Pittsburg Coal Co.....	Coal	785.50
	79	W. H. Pritchartt & Co.....	Subsistence.....	16.84
	80	Peatross, Cameron & Co	Coal	210.00
	81	Solomon, Johnson & Brady.....	Subsistence	18.58
	82	Jas. A. Tappan.....	Coal	227.50
	83	Evander Williams & Co	Subsistence.....	78.22
	84	Walter & Co.....	.....do	78.07
	85	G. D. Williamson, by John A. Haynes, attorney in fact.	.....do	24.33
	86	Wrought Iron Range Co.....	Water backs.....	17.15
	87	Western Iron and Supply Co.....	Siphons, etc	54.25
	91	Hired men.....	Services	393.00
	92	St. Louis, Iron Mountain and Southern Railway Co.	Commutation ticket	12.25
	93	The Chicago Herald Co.....	Advertising	12.00
	94	Engineering News Publishing Co	.....do	4.80
Apr ...	2	Hired men.....	Services	453.00
	3	.....do	.....do	1,895.00
	4	.....do	.....do	234.83
	5	.....do	.....do	1,440.00
	10	Lee Bros.....	Supplies	85.41
	24	John McCauley.....	Services	15.17
	26	Western Union Telegraph Co	Telegrams	4.77
	31	Hired men.....	Services	481.82
	32	Chester Harding, first lieutenant, Corps of Engineers.	Mileage.....	20.60
	35	F. W. Morrison.....	Traveling expenses	4.50
	36	Charles E. Thompson	.....do	4.50
	37	Joseph F. Vincent.....	.....do	4.50
	38	Isaac C. Richardson	.....do	4.50
	78	A. S. Aloe Co.....	Blue prints	12.75
	79	The Ætna Powder Co	Dynamite.....	60.00
	80	Baldwin, Knowlton & Lake	Subsistence.....	81.55
	81	Berton & Werner.....	.....do	46.80
	82	Alois Boschert & Co.....	.....do	286.82
	83	W. W. Butler.....	Spar	20.00
	84	Big Muddy Coal and Iron Co.....	Coal	180.00
	85	Crown Coal and Tow Co	.....do	87.92
	86	Cairo City Coal Co.....	.....do	142.60
	87	Consolidated Coal Co. of St. Louis.....	.....do	186.75
	88	Carroll & Powell.....	Services of diver.....	152.50
	89	Chicago and Texas R. R. Co.....	Repairs.....	11.50
	90	P. H. Dempsey.....	Subsistence.....	35.55
	91	Eagle Boat Store Co.....	Sheet gum.....	2.88
	92	Fly & Hobson	Subsistence.....	36.17
	93	Huse & Loomis Ice and Transportation Co.	Coal	39.00
	94	Henry A. Koettker.....	Subsistence.....	88.15
	95	Matt Monaghan & Co	.....do	91.22
	96	The Oliver-Finnie Grocer Co	.....do	173.81
	97	Pittsburg Coal Co.....	Coal	525.00
	98	Solomon, Johnson & Brady.....	Subsistence.....	7.15
	99	Carl Setz	.....do	3.25
	100	Jas. A. Tappan.....	Coal	135.10
	101	Walter & Co.....	Subsistence.....	49.80
	102	Evander Williams & Co.....	.....do	114.92
	103	G. D. Williamson	.....do	7.75
	104	James R. Gray.....	Administering affidavits....	.50
	108	Edward Culver.....	Traveling expenses.....	5.40
	109	Pat Norton	Repairing furnace.....	27.00
	110	Hired men.....	Services.....	1,430.00
	111	.....do	.....do	762.50
	112	.....do	.....do	400.00
May ...	1	Geo. W. Richey	.....do	55.00
	38	Western Union Telegraph Co	Telegrams	3.30
	40	Paddock-Hawley Iron Co.....	Iron and steel	21.10
	45	St. Louis, Iron Mountain and Southern Railway Co.	Commutation ticket	12.25

TABLE NO. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1895.				
May...	46	Chas. J. Allen, major, Corps of Engineers.	Mileage	$20.58
	47	Chester Harding, first lieutenant, Corps of Engineers.	....do	20.60
	51	Simon Taper	Services	15.00
	52	Chester Harding, first lieutenant, Corps of Engineers.	Mileage	81.18
	56	....do	....do	20.51
	58	Hired men	Services	453.00
June...	3	Edward Culver	Traveling expenses	9.00
	10	Hired men	Services	853.33
	11	....do	....do	1,429.00
	63	Western Union Telegraph Co	Telegrams	1.22
	64	M. M. Buck Manufacturing Co	Zinc	2.04
	65	Anton Lutz	Subsistence	29.65
	66	G. F. Meyer & Co	....do	40.45
	67	David Nicholson	....do	13.90
	68	John Rohan & Son Boiler Works Co	Labor and material	374.48
	69	E. H. Warner & Son	Lumber	42.56
	70	Charley Smith	Services	18.00
	99	Anchor Line Store	Subsistence	34.99
	100	Bodenheimer, Landau & Co	....do	7.67
	101	Michael Bennett	Labor and material	47.20
	102	Alois Boschert & Co	Subsistence	66.51
	103	Cahill, Swift & Co	Pipe	6.88
	104	M. Dougherty	Subsistence	67.98
	105	H. L. Ettman & Co	Sponges	4.25
	106	Goddard-Peck Grocer Co	Subsistence	128.57
	107	Henry A. Koettker	....do	36.45
	108	A. M. Nelson Paint Co	Paint brushes	5.50
	109	L. M. Rumsey Manufacturing Co	Steam fittings	26.46
	110	Rumsey & Sikemeier Co	Pipes, etc	24.22
	111	E. E. Souther Iron Co	Iron and rivets	42.16
	112	J. D. Streett & Co	Oils, etc	129.26
	113	Simmons Hardware Co	Scrub brushes, etc	15.08
	114	James Sweney & Son	Copper gutter	57.30
	115	Schoellhorn-Albrecht Machine Co	Castings	4.42
	116	St. Louis Ice Manufacturing and Storage Co.	Ice	10.00
	117	Western Anthracite Coal Co	Coal	14.82
	118	Ward Bros. Produce Co	Subsistence	18.88
	132	American Express Co	Express charges	.85
	133	Detrick Supply Co	Steam fittings	1.38
	134	Ewald Iron Co	Steel, etc	97.46
	135	H. L. Fox & Co	Supplies	21.65
	136	John J. Ganahl Lumber Co	Lumber	32.91
	137	National Lead Co	White and red lead	60.00
	138	Platt & Thornburgh Paint and Glass Co	Paints	13.25
	139	South St. Louis Foundry	Castings	15.84
	140	Carl Setz	Subsistence	7.50
	141	George Wenger Machinery and Supply Manufacturing Co.	Castings, etc	46 44
		Total expended		78,270.52
		Total of outstanding liabilities June 30, 1895.		
		Hired men	Services	300.00
		R. L. Creamer	Traveling expenses	9.00
		W. O. Shepard	....do	9 00
		Hired men	Services	895.00
		....do	....do	1,428.00
		Anchor Line Store	Calking cotton, etc	6.35
		Alois Boschert & Co	Subsistence	107.14
		Chas. W. Barstow	Paints, brushes, oils, etc	116.17
		The City of St. Louis	Hose	15.00
		J. S. Costello & Son	Brushes	3.00
		M. Dougherty	Subsistence	16.81
		Detrick Supply Co	Oilers	5.60
		Eau Claire St. Louis Lumber Co	Lumber	33.25
		Chas. W. Goetz & Co	Cement	3.50
		S. E. Grote Paint Store Co	Paints, etc	4.15
		Huse & Loomis Ice and Transportation Co	Ice	20.00
		Andrew F. Koettker	Subsistence	70.85
		Anton Lutz	.....do	31.80
		A. Moll Grocer Co	.....do	5.10
		C. F. Meyer & Co	Subsistence, supplies, etc	70.76
		A. M. Nelson Paint Co	Brushes and paints	4.50
		National Lead Co	White lead, etc	67.47
		David Nicholson	Brooms, etc	15.50
		Paddock-Hawley Iron Co	Rivets, etc	1.90

TABLE NO. 1.—*Detailed statement of expenditures, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
		Total of outstanding liabilities June 30, 1895—Continued.		
		Carl Setz	Subsistence	$7.75
		J. D. Streett & Co	Headlight oil	7.58
		St. Louis and Tennessee River Packet Co.	Freight charges	3.50
		E. E. Souther Iron Co	Steel and rivets	38.08
		Whitelaw Bros	Brushes and paints	40.40
		Ward Bros. Produce Co	Subsistence	28.84
		Gust Bischoff	do	108.60
		The Carnegie Steel Co., Limited	Plates	5.41
		Huse & Loomis Ice and Transportation Co.	Ice	27.50
		Andrew F. Koettker	Subsistence	63.12
		Anton Lutz	do	28.18
		G. F. Meyer & Co	do	41.80
		A. M. Nelson Paint Co	Varnish, oils, etc	42.34
		National Lead Co	Red and white lead	41.77
		David Nicholson	Subsistence	264.17
		Carl Setz	do	7.50
		Ward Bros. Produce Co	do	32.26
		F. J. Wehrfritz	do	25.80
		Total outstanding		4,054.45
		Total expended and outstanding		82,324.97
		Amount of this year's appropriation to be applied to repairs of the snag boat H. G. Wright, under contract with the Iowa Iron Works dated March 13, 1895		17,675.03
		Total amount expended, outstanding, and covered by uncompleted contracts		100,000.00

TABLE NO. 2.—*Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb in connection with the work of removing obstructions in Mississippi River during fiscal year ending June 30, 1895.*

Application.	1894.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Office expenses	$553.48	$400.00	.....	$659.89	$353.00	$304.23
Supervision	4.00	66.08	$21.64	.....	39.88	55.78
Expenses of snag boat H. G. Wright:						
Crew	1,681.69	3,938.17	.....	2,190.00	2,190.00	4,380.00
Outfit	.....	1,201.03	11.98	.....	19.10	.25
Fuel	.....	239.60	965.90	231.20	633.20	470.04
Subsistence	.....	809.43	492.74	101.09	245.79	751.68
Supplies	.....	95.23	.....	11.50	146.08	47.85
Repairs	.....	41.26	60.25	.....	128.52	96.76
Miscellaneous	.....	.....	9.76	.....	21.07	.....
Expenses of snag boat J. N. Macomb:						
Crew	276.66	2,169.00	.....	4,342.00	.....	4,349.00
Outfit	.....	.....	182.50	.....	175.02	.....
Fuel	.....	457.40	552.50	630.00	1,046.50	1,131.65
Subsistence	.....	714.94	309.95	.....	751.00	316.07
Supplies	.....	42.00	.....	.....	8.25	10.75
Repairs	.....	86.61	27.55	73.85	.....	17.55
Miscellaneous	.....	2.85	.....	.....	.....	27.20
Total	2,515.83	10,263.60	2,634.77	8,239.53	5,758.01	11,907.81

TABLE No. 2.—*Summary of expenses for operating U. S. snag boats, etc.*—Continued.

Application.	1895.						
	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
Office expenses	$356.38	$402.26	$2.87	$857.77	$456.30	$301.22	$4,647.40
Supervision	108.75	98.62	23.05	233.10	142.87	.....	793.77
Expenses of snag boat H. G. Wright:							
Crew	2,190.00	2,170.00	.....	3,389.32	70.00	1,748.33	23,956.51
Outfit	42.80	58.16	.....	.....	.....	11.32	1,344.64
Fuel	837.87	1,382.38	537.78	707.35	.....	.....	6,005.32
Subsistence	680.98	1,006.55	284.27	320.27	.....	497.05	5,189.85
Supplies	102.22	122.49	16.70	108.29	.....	241.85	892.21
Repairs	117.59	74.69	18.15	38.50	.....	18,065.35	18,641.07
Miscellaneous	.....	24.23	59.37	36.65	.....	31.35	183.03
Expenses of snag boat J. N. Macomb:							
Crew	2,160.00	2,167.00	421.00	2,870.00	.....	2,875.00	21,629.66
Outfit	19.10	117.63	53.50	.....	.....	11.70	559.45
Fuel	1,243.50	2,309.05	882.00	589.02	.....	14.82	8,856.44
Subsistence	741.09	1,069.38	231.70	702.67	.....	898.98	5,735.78
Supplies	65.80	212.90	.75	.....	.....	294.85	535.30
Repairs	.....	63.44	.....	.....	21.10	597.17	987.27
Miscellaneous	.....	.....	.....	.....	12.25	.....	42.30
Total	8,666.08	11,278.78	2,531.14	9,852.94	702.52	*25,588.99	*100,000.00

* Includes $4,054.45 outstanding liabilities and $17,675.03 applied to contract for repair of the snag boat H. G. Wright, but remaining unpaid on June 30, 1895.

REPORT OF FIRST LIEUT. CHESTER HARDING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., June 30, 1895.

MAJOR: I have the honor to submit in compliance with your instructions a report on the snag boats *H. G. Wright* and *J. N. Macomb*, operating under your charge.

The scope of this report is limited by your letter of July 17, 1894, in which I received instructions as follows:

"In addition to the general duties as inspections, etc., that may be required of you from time to time, you will please charge yourself with matters pertaining to construction and repair of the snag boats under charge of this office; also with superintendence and revision of the drawings pertaining to those boats."

These snag boats were generally described and their manner of operation given in your annual report, page 1568, Report Chief of Engineers, 1894. They have been so long in operation and their work is so generally known that a more detailed account of their manner of operation is probably unnecessary. It may be of interest, however, to give somewhat fuller descriptions of their construction than are readily available elsewhere.

The predecessors, and in some respects the prototypes of these iron boats with twin bows, butting beams, and rollers, were the wooden boats *Long*, *Abert*, and *De Russy*. They were operated much as the present boats are, but consisted of two separate hulls throughout, the wells extending fore and aft clear through the boats. The decks bridged the wells aft of the forecastles, and the engine rooms, etc., extended across uninterruptedly from one hull to the other. In the present boats the twin bows are retained, but the well terminates at a distance of about 65 feet aft from the stems, and thence to the stern of the boat there is a single hull.

The *Macomb* was the first of the iron snag boats. She was designed and built under the immediate supervision of Lieutenant-Colonel (then Major) Suter, Corps of Engineers, and came out in 1874. She was strongly built, and after twenty years' continuous service is still in sound condition without having had any general repairs. The *Wright*, also built under Colonel Suter's direction, has been actively employed since her completion in 1881, but her bottom has deteriorated and pitted under the action of the water more rapidly than in the case of the *Macomb*, and in the autumn of 1894 it was determined to renew her plating below the water line throughout the bottom.

The two boats are very similar in form and design, and have essentially the same equipments for snagging work. Both are thoroughly fitted out with machines and tools for making such minor repairs to the boats, engines, and machinery as are liable to be necessary in the course of their work. They differ mainly in the con-

struction of their hulls, and these I shall endeavor to describe in sufficient detail to point out the difference between them and to give an understanding of both. I shall then give an account of the alterations and repairs now in progress on the *Wright* under contract with the Iowa Iron Works, of Dubuque, Iowa.

DETAILS OF THE MACOMB'S HULL.

The *Macomb* is 177½ feet long over all by 62 feet beam and 90 feet over wheel guards. Her depth of hold is 8 feet, and her draft about 4 feet when equipped for work. The stems of the twin bows are 36 feet apart, and the well between the bows narrows to 10 feet width at its after end, a distance of 65 feet directly aft from the stems. A transom and rake terminate the well, and the rake joins the flat bottom 22 feet aft from the transom. The main deck has a crown (rise at center of midship cross section) of 8 inches, and a reversed sheer of 2 feet fore and aft from center. The modeling of the bows begins at a cross frame 60 feet aft from the stems; and from the same frame aft to the beginning of the skegs the sides are straight and vertical. The skegs are 54 feet apart, and are joined by a transom arched vertically to conform to the curve of the deck. The bottom along the straight body of the boat is flat, and is joined to the sides by a knuckle or bilge in cross section the quadrant of a circle. The sides of the well are vertical except forward where the bows begin to model.

The cross frames of the hull are spaced 15 inches apart throughout, and are of 2½ by 2½ by five-sixteenths inch angle irons with webs of one-fourth inch iron 6 inches deep riveted to them. The webs have a 2 by 2 by one-fourth inch reversed angle iron riveted along their upper edges. When the knuckles are reached the webs are diminished to 2½ inches in depth, and up the knuckle 2½ feet from the bottom, the webs and reversed angle irons are discontinued altogether, and the bottom angles alone extend upward to form the side frames. On the inside of the side frames, two one-fourth inch plates 6 inches deep, called side stringers, extend the full length of the boat, and are laid flat against the frames and secured to them by strips of angle iron. On the inside of the forked portion of the hull they terminate at the end of the well rake. Above these side stringers, there extends on each side the full length of the boat, and on the sides of the well to the end of the well rake, a one-fourth inch plate 12 inches deep, called a clamp, laid flat against the frames under the deck beams and secured to the frames by angle clips. The deck beams, formed of 1½ by 1½ by three-sixteenths inch angle irons and vertical webs 6 inches deep and three-sixteenths inch thick, are spaced 30 inches apart, and stretch across from clamp to clamp.

Resting on top of the cross frames and riveted thereto are 19 longitudinals, termed binding strakes, spaced as follows: One is in prolongation of the center line of the well, and one in prolongation of either side of the well; these three end forward with the well rake and extend aft to the transom. Nine divide the hulls on either side of the well into equal parts and extend the full length of the boat. These binding strakes are of T iron 2½ by 2½ inches by three-eighths inch, except the middle one, which is a plate 6 inches deep placed on edge and secured to the frames by angle irons, and except also those which coincide in position with the longitudinal bulkheads to be presently described; these latter are of angle irons 2 by 2 inches by one-fourth inch placed in pairs and riveted back to back through the bulkhead plates. In addition to these binding strakes, six keelsons, extending from stems to transom, serve to stiffen the hull longitudinally. The two main keelsons, running from the stems directly aft, are of one-half inch plate iron 9 inches deep, set on edge and secured by pairs of angle irons to the cross frames. The four bilge keelsons are of one-fourth inch plate 6 inches deep, similarly fastened to the cross frames.

The hull is divided up into 24 water-tight compartments by six fore and aft and four cross bulkheads. The first cross bulkhead is in rear of the butting beam in each fork of the hull; the second at the end of the well rake; the third under the forward end of the boilers, and the fourth at the forward end of the after rake. The first is of five thirty-seconds inch, the second of three-sixteenths inch, the third of five thirty-seconds inch, and the fourth of one-eighth inch iron plate. Adjoining plates in the bulkheads are fastened by double riveted butt straps of the same thickness as the plates they join. The keelsons, binding strakes, and longitudinal bulkheads run through the cross bulkheads, and in the angles formed by their intersections angle irons are fitted to make water-tight joints.

Two of the longitudinal bulkheads are located in prolongation of the sides of the well and the other four divide the distance on either side of the well into equal parts. The four outside bulkheads extend from the first cross bulkhead and the two inner from the second to the after cross bulkhead. They are secured to the cross frames by the double angles already described and extend to the skin of the boat, to which they are fastened by 1½ by 1½ by three-sixteenths inch angles worked between the cross frames. Double riveted butt straps secure adjoining plates as in the case of the cross bulkheads. Stanchions of 1½ by 1½ by three-sixteenths inch angle iron

spaced 3 feet apart are riveted to bulkhead plates. There are also rows of stanchions spaced 3 feet centers along the main keelson and the center binding strake. The stanchions are attached to the flanges of the angle irons of the keelsons and the corresponding deck stringers, which are secured to the deck beams along the longitudinal bulkheads and immediately over the main keelsons and the center binding strake.

Upon this skeleton the plating or skin is worked in fore and aft strakes about 3 feet wide. Adjoining strakes are alternately inside and outside, and connected by lap joints; and adjoining plates in each strake are connected by butt joints. The strakes gradually narrow to the stems and occasionally, to enable them to conform to the modeling of the bows, adjacent strakes near the stems merge into a single one by means of "stealers."

The plates are of different thicknesses in different parts of the boat, as follows:

The middle strake of each bow is seven-sixteenths inch, the full length of the boat; the flat bottom for 120 feet from the stems is five-sixteenths inch, thence to the transom three-sixteenths inch; the well rake is one-half inch to the dead flat, thence aft to the after rake five-sixteenths inch, and thence to the transom three-sixteenths inch; the knuckle is turned with a strake of seven-sixteenths and five-sixteenths inch, the thicker plating being used for a distance of 120 feet from the stems on the outside and for the bilges along the well to the end of the well rake; the sides are one-fourth inch throughout and the sheer strake immediately adjoining the deck is three-sixteenths inch thick. The main deck is covered with plates of three-sixteenths inch thick throughout, and all the seams are flush and fitted with butt straps. Hatches give entrance from the deck to all the compartments of the hold.

It is to be noted that in the *Macomb's* framing system the cross frames are the main dependence for the support of the skin. Except for the longitudinal bulkheads no fore and aft members extend to the bottom of the boat, and the cross frames are numerous and everywhere in contact with the skin plating. In the description of the original construction of the *Wright's* hull, to follow, it will be seen that the longitudinals form the support of the plating, and only along the bilges, the sides, the well rake, and the forward part of the bows is the plating in contact with the cross frames.

DETAILS OF THE WRIGHT'S HULL.

The *Wright* is 187 feet long by 62 feet beam and 92 feet over wheel guards. Her draft is about 3½ feet when fully equipped and her depth of hold is 8 feet. Her deck has a crown of 8 inches and from the center a reversed sheer forward of 2 feet and a sheer aft of 6 inches. Her stems are 36 feet apart and the well between bows gradually narrows to 8 feet. The stern posts are connected by a transom 57 feet wide. The frames along the side, the side stringers, clamps, deck beams, deck stringers, and stanchions are generally similar to those already described for the *Macomb*, except that the side frames are spaced 18 inches. The plating is in alternate inside and outside strakes, extending from end to end of boat. This statement applies to all strakes except the middle two, which are both outside strakes and are fastened together throughout their length by a double riveted butt strap. Beginning with the strakes adjoining the bilges each strake is riveted to a longitudinal plate frame that extends throughout the length and along the middle line of the strake. Adjoining strakes are connected throughout by double-riveted lap joints, except the middle two strakes referred to above, and the plates of each strake are connected by double-riveted butt straps.

There are 22 of the longitudinal frames referred to above, spaced about 3 feet apart along the straight body of the boat, and gradually approaching each other forward as the modeled parts of the bows are reached. They are formed of angles 2 by 2 inches by one-fourth inch, with a vertical web of iron plate 14 inches deep riveted to them. Along the upper edge of the webs are secured angles 2½ by 2½ inches by one-fourth inch in pairs placed on either side of the web and riveted through and through.

There are 64 cross frames. The first four spaces between frames, counting that between the stems and frame No. 1, are each 2 feet; the following 59 are 3 feet, and the last, between No. 64 and the transom, is 2 feet. From frame No. 9 to frame No. 57, between outboard longitudinals, the even-numbered frames are omitted in the original construction of the boat.

Cross bulkheads are located at frames Nos. 9, 31, 43, and 57.

Frames from No. 1 to No. 8, inclusive, extend to the bottom of the boat, and are formed of angles and vertical webs of iron plate.

Frames Nos. 11, 15, 19, 23, 27, 35, 39, 47, 51, and 55 are plate frames.

Frames Nos. 13, 17, 21, 25, 29, 33, 37, 41, 45, and 49 are bracket frames.

The plate frames are thus constructed: Angles, 2½ by 2½ inches by five-sixteenths inch rest on top of the longitudinals, and to them are riveted plates 14 inches deep by three-sixteenths inch thick, which are placed between longitudinals and fastened

to them by corner angles 2 by 2 inches by one-fourth inch. The bottoms of these plates are raised 3 inches above the skin of the boat.

The bracket frames are formed of angles 2 by 2 inches by one-fourth inch, resting on top of the longitudinals, to which they are fastened by three-sixteenths inch gussets.

Four longitudinal bulkheads, one over each keel and one in prolongation of each side of the well, divide the hold by their intersections with the cross bulkheads into 24 water-tight compartments.

For the framing of the well rake the middle two longitudinals are extended forward from frame 31 to the well transom, rising to fit the curve of the rake. Across them and spaced 3 feet centers are worked 8 cross frames, formed of angles 2½ by 2½ inches by five-sixteenths inch resting on top of the longitudinals, and plates three-sixteenths inch thick worked between the longitudinals, riveted to the angles, and fastened to the longitudinals by corner angles 2 by 2 inches by one-fourth inch. These plates extend to the skin of the rake, and are fastened to it by angles 2½ by 2½ inches by five-sixteenths inch.

The frames aft of No. 57, where the after rake begins, are all bracket frames similar to those described for the flat bottom of the boat.

REPAIRS AND ALTERATIONS NOW IN PROGRESS ON THE WRIGHT.

When in the autumn of 1894 it was determined to renew the plating of the *Wright*, it was thought desirable to take advantage of the opportunity to make some alterations in the framing of the hull, with the object of giving a somewhat stronger and stiffer construction.

The specifications for the work, therefore, included the following alterations and repairs:

The even-numbered cross frames which were omitted in the original construction are to be introduced. The frames designated as bracket frames are to be changed to plate frames, and the existing plate frames are to be brought down to the skin and fastened thereto by means of 3 by 5 by five-sixteenths inch angles worked in between longitudinals. The new plate frames and the altered bracket frames will have their webs brought down to the bottom and fastened thereto by 2 by 2 by one-fourth inch angles. The knuckle strakes, the side strakes of the well, the well rake, the after rake, and the entire bottom of the boat will be renewed. The new plates will be of the following thicknesses: For the well rake seven-sixteenths inch, for the sides of the well five-sixteenths inch, for the knuckles three-eighths inch, and for the bottom and after rake five-sixteenths inch.

The material for all new work is to be of mild steel answering the following requirements: Ultimate tensile strength, 50,000 to 60,000 pounds; elastic limit, one-half of the ultimate strength; minimum elongation, 26 per cent in 8 inches, and minimum reduction of area at fracture 50 per cent.

Coupons of plates from each heat are required to be furnished for bending tests; after being heated to a cherry red and immediately chilled in water, they are to be bent cold 180 degrees flat, without showing sign of fracture on the outside of bent portion.

A contract was entered into on March 13, 1895, with the Iowa Iron Works, of Dubuque, Iowa, for the execution of the proposed work, their bid of $22,900 being the lowest received.

The terms of the specifications required them to make arrangements for dockage and to include in the amount of their proposal the cost of dockage during the entire period of the work. They were also required to furnish all plant, labor, and materials. As it was not desired to have the boat go where a period of low water might prevent her immediate return to duty upon the completion of the work, and as her width is too great to admit of her passage through the locks of the Des Moines Rapids or Louisville and Portland Canal, there was little competition in the matter of dockage. The yards of the Mississippi Valley Marine Railway and Dock Company, at Mound City, Ill., were selected by the contractors. At the date of this report the state of progress of the work is as follows:

The boat has been docked, and about three-fourths of the plating has been removed, all that is safe to remove until some new plates are in place. The plates and angles for the new work have been rolled, inspected, and accepted. The material for the renewal of certain additional frames which the removal of plating has shown to be in bad condition has been ordered. The date fixed by the contract for the completion of the work is August 1, 1895.

The chilling and bending tests of the new material, which of all the requirements are perhaps the most critical, were all made under my personal direction, and gave entirely satisfactory results. The other tests were made in the laboratories of the manufacturers, and records thereof submitted before the acceptance of the steel.

For the plates, rolled by Park Brother & Co., Pittsburg, these records are as follows for the different heats:

Heat.	Tensile strength per square inch.	Elastic limit per square inch.	Elongation in 8 inches.	Reduction in area.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
1	60,010	39,410	26	59.3
2	54,060	38,920	26.5	67.7
3	54,780	39,730	30	69.5
4	53,670	39,380	28.75	68.9
5	56,360	40,520	26	66.2
6	60,020	39,170	26.5	56.2
7	57,000	39,770	26.75	66.3
8	54,320	37,570	27	65.4

For the angles, rolled by Jones & Laughlin, Pittsburg:

Heat.	Tensile strength per square inch.	Elastic limit per square inch.	Elongation in 8 inches.	Reduction in area.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
1	61,300	43,110	27.25	63
2	60,190	41,360	27	63.3

The corroding and pitting action of the water on this material remains to be determined by time. Judging by the behavior of very similar material on the bottom of the U. S. snag boat *C. R. Suter*, which for nine years has been operating on the Missouri River, the *Wright's* new bottom should prove satisfactory in this particular.

DESIGN FOR NEW WRECKING HOOK.

I desire to submit in connection with this report a design for a wrecking hook and to recommend its construction for the *Wright*. This boat is occasionally called upon to remove abandoned wrecks that form obstructions to navigation. The equipments for the removal of snags have been found to be inadequate for wrecking work, and in 1891 a design for a wrecking hook was adopted and has since been put to the test of actual service. In this device heavy hinges are secured to the deck immediately over the stems and in them fitted the feet of a heavy A frame at the head of which a beak-like hook is secured. When in operation, the boat being headed upstream, the whole frame is lowered about the horizontal axis through the hinges until the beak touches bottom above the wreck and the boat is allowed to drift with the current, the hook acting like a drag. Owing to the great weight of the boat considerable momentum is acquired, and when the beak catches a great force is exerted upon the wreck, tending to tear it apart.

The serious trouble with this design has been found to be with the hinges. If the boat swings at all as the hook catches, a violent stress is brought upon the hinges, and they break or tear up from their connections. There seems to be no way of securing the legs of the A frame to the stems with sufficient strength to withstand such violent wrenching.

In the accompanying design it is attempted to prevent this difficulty by attaching the hook to the butting beam, by a single leg of built-up construction, the connection between the leg and the butting beam attachment being of such a character as to give freedom of rotation about a vertical as well as a horizontal axis, thus avoiding the severe cross stresses referred to above. When the hook is not in use, the leg is to be detached from the hinge and the butting beam attachment removed. There are only two parts to be assembled in putting the device in place, the hook being permanently attached to the leg, and the beam attachment being also assembled once for all. All parts of the design, except the pins, are to be of mild steel, and all are calculated for a pull at the hook of 100 tons, with a factor of safety of 4.

I am indebted to Mr. Victor H. Poss, C. E., draftsman, for valuable assistance in working out the details of the design and for the accompanying drawing, which well exhibits the constructional details of the proposed device.

Very respectfully, your obedient servant,

CHESTER HARDING,
First Lieutenant, Corps of Engineers.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

W 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

The object of the improvement is to obtain eventually a minimum depth at standard low water of 6 feet from the mouth of the Missouri River to St. Louis, a distance of 16 miles, and of 8 feet at the same stage of water from St. Louis to the mouth of the Ohio River, 178 miles, the natural depth being in many cases from 3½ to 4 feet. The channel is divided at a number of points by islands forming sloughs and secondary channels behind them, through which a good deal of the volume of flow is diverted, to the detriment of navigation.

The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, proceeding downstream from that city.

The first work for improvement began in 1872, and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone, erected with a view to confining the low-water volume to one channel, and of revetments to hold and preserve the banks where necessary or advisable.

The present project is a continuation of the plan adopted in 1881, and contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles. The method employed is the building up of new banks out to the line desired from the solid matter brought down by the river, and which is collected by means of hurdles. The banks, both new and old, are revetted where necessary. Other means are also used occasionally for completing or hastening the depth required.

A hurdle, as the term is here used, is one of many silt-arresting devices that have been experimented upon in this country and elsewhere. The hurdle consists, essentially, of a row or of parallel rows of piling, the piles driven either singly or in clumps, the piling being connected lengthwise of the hurdle by wattling of fine brush or by curtains composed of brush and lodged against the upstream side of one of the rows of piles, the whole forming a permeable dike through which the silt-laden current can pass, though with greatly diminished velocity, resulting in deposits of silt above and below the hurdles.

These deposits are generally soon overgrown with willows or cottonwood, and after they arrive at sufficient height they can be revetted on their river fronts.

To guard against loss by scour of the piles, a broad flexible mattress is first sunk on the line of the hurdle. Through this mat the piles and clumps of piles are driven.

During the past year the hurdles have been constructed of clumps of piles, three piles and upward to each clump. These piles are driven so that when their upper ends are drawn together by means of a wire rope they form a sort of pyramidal structure, the horizontal distances of the piles from each other at the surface of the river bed being 8 to 10 feet, depending mainly upon the depth of the water.

The wire ropes are made on the work; they are composed of 14 to 18 strands of No. 14 galvanized-iron wire. They are drawn taut by means of the pile-driver machinery. At each turn of the rope round the upper end of the clump of piles a spike is driven as an additional guard against the rope slipping, though the wire itself generally binds or cuts into the piling sufficiently to prevent any slip. This method of drawing the upper ends of the piles together appears to be better than the old one of bolting them.

The tops of the piles are generally at an elevation of 20 feet above exteme low water, excepting that in the curtain or wattling row the top of one pile of the clump is at an elevation of about 25 feet above that stage in order to intercept drift at high stages and prevent it from crossing the line of hurdle and dragging the top of the latter with it.

The curtain or wattled row is braced by vertical diagonal braces heeled against a row of clumps spaced at such distance below as to make the angle of the braces about 45 degrees.

The heel of the brace is held by a clevis passing around one of the piles of the lower clump, with its pin through the brace. At top the brace is bolted to one or more of the piles in the upper clump.

The piling of the hurdle row is so spaced as to represent an equivalent of one pile to the linear foot of hurdle. The piles are driven by means of the hydraulic jet as well as by the hammer, the latter weighing 2,400 pounds, and sometimes by both combined.

The completed curtain, or the wattling, whichever may be used, is generally carried finally to a height of 20 feet above extreme low water. The mattress is from 60 to 135 feet in width, depending upon the depth of water and consequent length of piles, as well as upon liability of the bed to suffer from scour. It is fabricated upon floating ways, in place, by wattling brush upon poles spaced about 5 feet apart and in any length desired. Continuity is obtained by lapping the poles and fastening them together with spikes and wire. When additional strength is required wire cables are used across and in the direction of the length of the mattress. The brush is spiked to the poles at the edges of the mattress and at other points, about one spike to every third pole. In sinking the mat a little less than 1 cubic yard of broken rock is required to a cord of brush.

The piles used in the hurdles run in lengths from 25 to 60 feet, and their average penetration in the bottom is about 15 feet. They are driven with the large end down.

At the shore end of the hurdle the bank is revetted for about 300 feet, of which 200 feet are below the axis of the hurdle.

In constructing the shore revetment a mat about 120 feet or more in width, its inner edge at the surface of standard low water, is sunk. The bank is then eventually graded to a slope of one-half and covered with riprap. Where necessary to grade the bank by artifical means the grading is done by the hydraulic method or by means of shovels, etc.

The foregoing is a general description of the work of construction during the past year.

At the beginning of the fiscal year the work for improvement had extended to Fort Chartres Crossing, or Bruce Island, but the construction at several points had been left incomplete, especially as to number and extent of works, partly in order to observe the effect of the hurdle as built. A number of new banks, the result of deposits induced by the hurdles, will require revetment to secure their permanency as soon as they become high enough, notably so at Horsetail, Twin Hollows, and Jim Smith's.

The localities upon which work was done during the year extended from St. Louis down to and including the head of Moro Island, opposite Ste. Genevieve, Mo. The work done during the year is as follows:

HORSETAIL BAR, IMMEDIATELY BELOW ST. LOUIS.

The work at this locality consisted in extension of the bank protection on the west side of the river. Two hundred and ninety linear feet of stone and mattress revetment were placed, the mattress work extend-

ing below the water surface and the stonework to a line 12 feet above low water.

PULLTIGHT, 7½ MILES BELOW ST. LOUIS.

The work at this locality consisted in continuing the additions and extensions begun to the series of hurdles at this point in the spring of 1893. Two buttresses of brush and stone at the river ends of hurdles 0 and 1 were raised, and buttresses of the same materials were built to the same height at the river ends of hurdles 0½ and 2. These buttresses were placed for the purpose of protecting the river ends of these hurdles, which are situated along a slightly concave line, from the action of the ice as it breaks up in February or March.

The depth at this crossing is now not less than 8 feet where in the early part of 1893 it was but 4½ feet.

SULPHUR SPRINGS, 15 MILES BELOW ST. LOUIS.

Considerable trouble was experienced at this locality on account of shoal water before improvements were begun, and also during the low-water season of 1893. The channel, in crossing from bank to bank of the river, made two abrupt changes of direction nearly at right angles to the axis of the stream. The improvement was begun in 1887, but the work of the past year has added to the number of hurdles, and some of those previously built were extended and repaired during the year.

The low stage of water during the past spring interfered with the completion of the work, but that already accomplished has much improved the na vigation at this point. Number of linear feet of hurdles buil duringthe year, 7,595.

FOSTERS ISLAND, 17½ MILES BELOW ST. LOUIS.

A section of mattress, 100 feet in length, was placed in extension of the old revetment.

LUCAS, 20 MILES BELOW ST. LOUIS.

Some additions, extensions, and repairs were made to the hurdles built at this place in 1888–1890. Total linear feet of hurdle built during the year, 150. The work at this point is still in progress.

CORNICE ISLAND, 23 MILES BELOW ST. LOUIS.

Construction work commenced at this locality on the 1st of June on hurdles 1, 2, 3, 4, and 5, and the work was in progress at the close of the year. Total linear feet of hurdles built, 2,510.

MICHAELS, 27 MILES BELOW ST. LOUIS.

The work here consisted in construction of hurdle No. 1 and in the repair, so far as practicable, at the existing low stages of water, of No. 3 of the series which was built in 1892. Eight buttresses of brush and stone were placed about 300 feet apart on a line 80 feet from the hurdle, on its upstream side, to serve as protection against moving ice, to which this hurdle will be the most exposed. Four piers of stone connect the inshore end of this hurdle with the shore, the shelving rock near shore preventing pile driving for about 200 feet. Total number of linear feet of hurdles built, 3,250.

FORT CHARTRES, 40 MILES BELOW ST. LOUIS.

Navigation at this locality has always been more or less difficult. Work for its improvement was begun in 1875 by the partial construction of a dam to close the chute west of Bruce Island, then called Fort Chartres towhead. No further work was done here until 1892, when the building of a series of hurdles was commenced for the purpose of closing the chute. Two hurdles were built during the year named, but considerable damage was done to them when the ice in the river broke up in February, 1893.

During the spring of 1893 and the fiscal year, 1894, 10,250 linear feet of hurdles were completed for closing the chute, and the bank opposite was protected in part to a distance of 5,500 feet below Sycamore Landing.

The work of the past fiscal year consisted mainly in protection of the east bank of Bruce Island by means of revetment carried up the shore to the foot of the abrupt bank.

At the begining of the extreme low-water season of last year, a shoal with about 5 feet of water upon it developed in the channel crossing nearly opposite the landing at Fort Chartres, the river at the same time showing a tendency to split up into several channels, none of which would have sufficient depth.

With a view to deepening the water over this bar along the line that was being used by the steamers and tows, and in order to afford some temporary relief, at least to navigation, two portable jetties of a total length of 900 feet, and improvised from barges and grub plank, were experimented with at this locality. These jetties were placed so as to form a funnel-shaped chute concentrating the flow between them upon the bar. As the only practicable channel for navigation at this time lay between the jetties, and as towboats with tows were obliged to make the crossing between the jetties by "flanking," which required a good deal of space, the jetties could not be placed as near each other, and especially so at their lower ends, as was necessary or desirable, and this fact, taken in connection with the short length of the jetties, was unfavorable to full demonstration of the experiment.

As it was, however, a narrow channel, 9 feet deep, was soon excavated parallel and near to the upper face of the lower jetty, and which could have been enlarged by the operation of a powerful sand pump had one been available then. An accumulation of sand formed, though below and in juxtaposition to the lower jetty and between this bar and one but a short distance below it, one of the narrow channels already mentioned into which the river appeared to be splitting up was deepened to 7 feet, which depth was increased to 9 feet, with ample width, by the aid of pile-driver jets directed against the crest of the bar, which was a short one, axially. This experiment began September 5 and terminated September 20, the desired depth having been obtained.

It would have been interesting to have made further experiments with these jetties, but as the necessary depth for navigation had been obtained and as there began to be need for the barges elsewhere they had to be withdrawn.

It is not expected that such jetties can be relied upon alone to produce very marked results. But there may be occasionally times during seasons of low water when their use as auxiliaries to permanent works of contraction, and especially in connection with a suitable dredge, also regarded as auxiliary, may be of assistance to navigation, and even if such assistance takes only the shape of a small and temporary increase

in depth at one or more of the worst bars, it appears worth the while to employ such auxiliaries—to a limited extent, at least—for what they may be worth, particularly when the cost is but a few dollars per foot. This subject will be touched upon again and farther on in this report.

TURKEY ISLAND, 42 MILES BELOW ST. LOUIS.

The work at this island consisted in placing a mattress below the water surface and carrying the stone revetment up the bank for 15 feet above low water for the protection of 1,200 linear feet of the west face of the island. This work was in progress at the close of the year

STE. GENEVIEVE, 48 MILES BELOW ST. LOUIS.

The improvement of this reach of river, extending from Turkey Island to Kaskaskia Island, comprises several series of projected hurdles and revetments.

The work of the fiscal year for this reach consisted in repairing and in adding to the hurdles built in 1891 and 1892 for the improvement of the channel and landing at Little Rock, as provided for in the river and harbor act of 1890, and in the extension of this work down to Moro Island, protection of the west face of the island, and commencement of construction of a series of hurdles on the west side of the river at Stantons Landing at Ste. Genevieve.

Total length of hurdle constructed during the year, 6,575 linear feet; total length of revetment, 5,700 linear feet.

The work was still in progress at the close of the year.

DEVILS ISLAND, 114½ MILES BELOW ST. LOUIS.

The only work done at this locality consisted in the placing of a short portable jetty composed of several of the barges which had been used for the Fort Chartres experiment, the object being to secure some small increase in depth on the narrow bar, the ruling depth upon which was but 4 feet and that depth only existing in a channel which crossed the bar in a direction nearly at a right angle to the axis of the river.

The river at this locality is about 4,000 feet wide; last fall it had a low-water depth of 2½ to 4 feet throughout the entire width, and small velocity of current. It was the shoalest crossing between St. Louis and Cairo, and not only obstructed general navigation, but interfered with the movement of our own boats and barges engaged in procuring brush for the works at points 75 miles and more above.

A small gain in depth was effected by this jetty, aided by pile-driver jets, but a steamer of one of the navigation lines having a tow grounded in this channel, caused the bottom to flatten out, so that the increase was lost. But the increase in depth that had been effected was about as much as had been expected from the short length of jetty available.

Early in September last (1894) I had a conference at this office with one of the members of the committee on dredging of the Mississippi River Commission, which has charge of improvement work on the Mississippi River below the mouth of the Ohio, in regard to some proposed experimental operations of their dredge *Experimenter* above the mouth of the Ohio. It was understood as a result of the conference that the dredge, which was then working below the mouth of the Ohio, would probably soon move up to Devils Island, where the set of the current was reported as favoring operations by a dredge across a particular portion of the bar, and commence operations upon a line to be first sub-

mitted to this office. As the dredge, however, did not move up as soon as I had expected, it being still engaged below the Ohio, I addressed a personal note on the 9th of October to the secretary of the Commission to the effect that I had been expecting for several weeks past that the dredge would come up to this side of the Ohio River, and that there was a very good chance for trying it at Devils Island. Answer was returned to the effect that the dredge would probably move up shortly to Devils Island. It arrived on the ground about the 17th of October, and commenced work some days later. Some of the discharge pipes for the dredge were towed from St. Louis to Devils Island by the steamer *Dolphin No. 2*, at that time in the employ of this office, in order to assist those operating the dredge. The result of the dredging was a good channel for the rest of the season. The channel has also been in use this season, which has been one of unusually low water for this part of the year.

The total of construction work done during the year is as follows:

Hurdle built	linear feet	19,530
Hurdle repaired	do	550
Bank protection (revetment) built, including extensions and repairs	do	10,566

All of the work for placing material was done by hired labor.

MATERIAL USED.

The following quantities of piles, brush (for mattresses), and rock were used in the works during the year:

Piles	linear feet	764,929
Brush in place	cords	33,794.3
Rock in place	cubic yards	61,965.5

UTILIZATION OF DRIFTWOOD.

At high stages of the river immense quantities of driftwood are carried downstream by the flood. A great deal of this drift lodges against the hurdles, and sometimes in quantities sufficient to menace their stability either through static pressure or by producing scour about the piling. If the fields of drift thus formed can be sunk in place just above the hurdles they form excellent permeable dams, often of considerable height, and also serve as protection to the hurdles against which they have rested; but in general the drift must be sunk quickly, otherwise, especially at very high stages of water, it may become dangerous to the hurdles, as noted above.

The fields of drift are sunk by laying on top of them, rapidly and as evenly as possible, a sort of mattress of brush, and then weighting the whole with stone.

A good deal of such drift was utilized in this way during the year.

LABOR AND MATERIALS.

Of the brush used 14,496.2 cords were procured by hired labor and 19,298.1 cords by contract. Of the stone used 34,792.6 cubic yards were procured by hired labor at the United States quarry at Little Rock, Mo., a short distance above Ste. Genevieve, and 27,172.9 cubic yards by contract, and 133,327 linear feet of piling by purchase in open market and 631,602 linear feet by contract. Other materials, including rope, bolts, wire, spikes, nails, and miscellaneous supplies, were procured in open market. The work of placing the materials was all done by hired labor.

PLANT.

The plant that was on hand at the beginning of the fiscal year was insufficient for the proper expenditure of the appropriation of August 18 last, and of the subsequent (expected) appropriation of $758,333.33, and which was made March 3 last, and an increase of the plant by 1 tow and dredge boat, 12 model barges, and 15 skiffs was therefore authorized by the Department. The tow and dredge boat is building under contract, to be delivered on or before August 1 next, and the barges, also building under contract, are to be delivered by August 30, 1895. The skiffs were purchased under informal contract.

A full list of the plant is given in the table forming part of this report, giving the value of property.

In my project of August 28 for the expenditure of the appropriation by the act of August 16, 1894, appears the following:

It is also submitted that a dredge would be useful as auxiliary to the work, not only where contraction works have been and are being constructed, but it would also afford more or less relief at crossings generally between the Missouri and the Ohio.

The operation of the dredge would be to some extent experimental, but it could be expected to lessen difficulties to navigation at low stages of water by increasing the depths sooner than the contraction works would, though such dredged depths might be only temporary and might have to be renewed several times each season. A single dredge might not, however, suffice, and experience then would indicate the number required.

This is the boat already reported as authorized to serve as a tow and dredge boat.

PLATES.

Six plates accompany this report. Plate No. 1, on a scale of 1–100,000, is a map of the river from the mouth of the Missouri River to Big Eddy, a distance of 102 miles. This is a general map, showing localities, and location of completed and projected works. The other plates show the localities and works more in detail. The plates all aid materially to a full explanation of the work projected and completed.

GAUGES.

Daily gauge observations were continued under direction of this office at 12 localities, covering the river from the Chain of Rocks, above the northerly boundary of St. Louis, to Gray's Point, a distance of about 158 miles. The gauge readings show decided changes in stages of water and in slopes on the portion of the river under improvement immediately below St. Louis, but the full extent of such changes can only be given after the gauge readings shall have been further continued for several seasons.

The fiscal year just ended has been the longest period of low water ever recorded at the St. Louis gauge. The year opened with a falling river, the stage of water on the 1st of July being 17 feet on the gauge. It passed below the 10-foot stage July 22, to the 3-foot stage during November and December, and to the zero stage in January. In the spring months of April and May it nearly reached the 10-foot stage, but did not pass it until June 13. There was, then, a period of nearly eleven months in which the river fluctuated between the zero and the 10-foot stage.

CONDITION OF THE RIVER.

The plan for improvement has contemplated, since 1881, carrying the works downstream from St. Louis, making the improvement complete and thorough as it progressed—that is, so far as practicable to do so. It is not always practicable, however, to advance and maintain hurdle and revetment construction work in proportion to the extent of accretions, and hence while the aim and effort may be to thoroughly complete the work at one locality before proceeding to another, it generally becomes necessary to start new lines of hurdles or new revetments at other points in order to keep the work going. The accretions depend, as to dimensions, almost entirely upon frequency, height, and duration of floods from the Missouri River. When these floods are small, comparatively, and of short duration, smaller accretions may be looked for. It may take years before accretions at certain localities become broad enough or high enough to admit of their being revetted, and again there are sometimes periods when the stage of water in the river is so low that barges with material for the works, and occasionally even pile drivers, can not move about outside of the navigable channel for the time being so as to complete a work at some one point, and it then becomes necessary to utilize the time, men, and plant by working at some other point equally in need of improvement. During the fall of 1893 and 1894, and even during part of the past spring, the low water retarded construction considerably.

The navigable channel has been improved and ruling depths at low water have been considerably greater than prevailed throughout the reach under improvement (from St. Louis to Ste. Genevieve here referred to) before work for improvement began, and considerable improvement has been effected during the past fiscal year in spite of the difficulties mentioned under which work progressed. The least depth found during the year within this reach of river, and which formerly contained some of the shoalest bars between St. Louis and the mouth of the Ohio, was at Fort Chartres, where, as has already been stated, there was a depth of but 5 feet in the early part of September, at a 3½ foot stage on the St. Louis gauge, but which depth was soon increased to 9 feet. In general, it must be said, although the improvement is far from being completed, in fact being not much more than fairly begun, that the river between the mouths of the Ohio and Missouri is much better for navigation than it was before the work of improvement began, and that the difficulties and dangers to navigation are much less than they were twenty years ago. In giving credit for the improvement, the operations of the snag boats, in freeing the channels of snags and other obstructions, must not be overlooked.

Total amount of dams, dikes, hurdles, and revetments built by the United States since improvement was begun in 1872, and also total of accretions due to hurdles:

Dams	linear feet..	8,326
Dikes	do....	11,620
Hurdles	do....	309,801
Bank protection (revetment)	do....	136,625
Accretions due to hurdlework	acres..	7,045

The details of the work done during the fiscal year are given in the reports herewith of Mr. D. M. Currie, principal assistant engineer, Mr. William S. Mitchell, assistant engineer, and Mr. Gerald Bagnall, assistant engineer.

The procuring of brush and quarrying of stone by hired labor was done by parties in charge of Mr. E. D. Libby, assistant engineer.

ENGINEER DEPOT, FOOT OF ARSENAL STREET, ST. LOUIS.

At this depot were made most of the repairs to tools and appliances and minor repairs to the floating plant. An account, in detail, of this work is given in the accompanying report of Mr. C. D. Lamb, superintendent.

STATISTICS.

For amount of commerce and navigation benefited by the improvement, attention is respectfully invited to the tables herewith of statistics of the commerce of the river. These statistics were compiled by Mr. Elliott Jones, chief clerk.

VALUE OF PROPERTY.

The present value of property belonging to this work is shown in the following table:

Class of property.	Value July 1, 1894.	Purchases, additions, and repairs.	Expenses and deterioration charged to works of improvement.	Value June 30, 1895.
Steamer Gen. Gillmore (1)	$13,711.89	$20,755.08	$18,925.67	$15,541.30
Steamer Gen. T. L. Casey (1)	24,925.70	18,015.47	18,351.57	24,589.60
Steamer Dolphin No. 2 (hired)	.....	3,087.75	3,087.75	.....
Tow and dredge boat	.....	1,437.16	.....	1,437.16
Steam tenders (7)	20,326.91	12,784.79	6,901.78	26,209.92
Barges, model (46)	138,697.81	13,166.09	25,503.59	126,360.31
Barges, quarter (8)	16,176.63	4,039.49	4,104.70	16,111.42
Quarter boats (10)	51,104.59	2,268.09	3,488.36	49,884.32
Office and survey boats (4)	12,326.00	4,602.32	1,460.35	15,467.97
Pile drivers (35)	118,578.75	30,336.10	18,736.85	130,178.00
Derrick boats (2)	4,873.65	170.89	870.89	4,173.65
Derrick	1,011.50	1,048.71	300.44	1,759.77
Machine shop	1,590.07	496.06	798.16	1,287.97
Small boats (429)	61,575.97	12,033.61	29,297.83	44,311.75
Portable quarters	5,902.21	354.72	1,358.72	4,898.21
Portable jetties	.....	2,714.02	.....	2,714.02
Ways (supply depot)	3,584.98	311.23	992.38	2,903.83
Supply depot	4,280.25	2,807.46	2,550.11	4,537.60
Tools and appliances	13,343.92	7,929.61	8,231.82	13,041.71
Boarding outfit	25,374.03	7,716.03	6,634.57	26,455.49
Office furniture	533.48	.....	53.35	480.13
Survey instruments	1,910.26	11.50	.....	1,921.76
Photographic apparatus	257.14	.....	.....	257.14
Total	520,085.74	146,086.18	151,618.89	514,523.03

ESTIMATE.

The orignal estimate of cost of this improvement of the river between the mouth of the Ohio and the mouth of the Missouri River, as revised in 1883, is $16,397,500.

The aggregate amount from appropriations that has been available for this work to June 30, 1895, is $6,904,999.99, leaving the sum of $9,492,500.01 for further appropriation or consideration.

LIST OF APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$100,000.00	July 5, 1884	$520,000.00
March 3, 1873	200,000.00	August 5, 1886	375,000.00
June 23, 1874	200,000.00	August 11, 1888	300,000.00
March 3, 1875	200,000.00	September 19, 1890	400,000.00
August 14, 1876	200,000.00	July 13, 1892	525,000.00
June 18, 1878	240,000.00	March 3, 1893	658,333.33
March 3, 1879	200,000.00	August 18, 1894	758,333.33
June 14, 1880	250,000.00	March 2, 1895	758,333.33
March 3, 1881	600,000.00		
August 2, 1882	600,000.00	Total	7,084,999.99

Of these amounts $180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving as amount applicable for general improvement between the mouth of the Ohio River and the mouth of the Missouri River $6,904,999.99, as just given above.

Amount expended to include June 30, 1894, $5,190,490.18.

Amount expended during the fiscal year ending June 30, 1895, $382,204.74.

The balance available June 30, 1895, will be expended in continuing the improvement according to the approved project, and unless some unforeseen contingency interferes (none is apprehended, however) the balance will be practically expended by the close of the fiscal year ending June 30, 1896.

In addition to the actual work of construction there is a large and expensive plant to be maintained and cared for, and which will be increased by the number of boats (1 tow and dredge boat and 12 barges) now under construction by contract.

The safe harborage of the floating property during winters is always a matter of solicitude with this office.

The river and harbor act of July 13, 1892, contained the following:

Improving the Mississippi River from the mouth of the Ohio River to the landing on the west bank below the Washington Avenue Bridge, Minneapolis, Minnesota; continuing improvement, one million one hundred and twenty-five thousand dollars: *Provided*, That on and after the passage of this act additional contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry on continuously the systematic improvement of the Mississippi River between the points mentioned, or said materials may be purchased and work may be done otherwise than by contract, to be paid for as appropriations may from time to time be made by law, not exceeding in the aggregate one million six hundred and twenty-five thousand dollars per annum for three years, commencing July first, eighteen hundred and ninety-three: *And provided further*, That of the amount herein appropriated five hundred and twenty-five thousand dollars shall be expended from the mouth of the Ohio River to the mouth of the Missouri River and six hundred thousand dollars from the mouth of the Missouri to Minneapolis; and the amounts for which additional contracts are authorized to be entered into shall be expended in like proportion.

The amount contemplated to be expended annually on the Mississippi River between the mouths of the Ohio and Missouri rivers for three years, in addition to the appropriation of $525,000 of 1892, appeared to be, therefore, $758,333.33. The three appropriations, however, following that of 1892, were:

By act of—	
March 3, 1893	$658,333.33
August 18, 1894	758,333.33
March 2, 1895	758,333.33

These three appropriations are included in the amount given above as appropriated to date.

It is presumed that the appropriation of $758,333.33 is the last to be made under the provisions of the act of 1892.

The plant accumulated since 1892 in order to carry on the improvement at the rate that the act of 1892 provided for is in condition, with ordinary annual repairs to some of it, to last for a number of years to come.

The sum of $760,000 can be profitably expended during the fiscal year ending June 30, 1897, in continuing the work under the present approved project.

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ended June 30, 1895, amounted to $1,197,346.70.

The amount of internal revenue collected was $7,388,503.13.

Money statement.

July 1, 1894, balance unexpended		$197,843.15
Amount appropriated by sundry civil act approved August 18, 1894		758,333.33
Amount appropriated by sundry civil act approved March 2, 1895		758,333.33
		1,714,509.81
June 30, 1895, amount expended during fiscal year		382,204.74
July 1, 1895, balance unexpended		1,332,305.07
July 1, 1895, outstanding liabilities	$126,505.79	
July 1, 1895, amount covered by uncompleted contracts	155,780.55	
		282,286.34
July 1, 1895, balance available		*1,050,018.73

Amount (estimated) required for completion of existing project.....$9,492,500.01
Amount that can be profitably expended in fiscal year ending June 30, 1897..... 760,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for 12 model barges received in response to advertisement dated September 24, 1894, and opened October 24, 1894, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Barges.	Price.	Amount.
		Number.		
1	George T. Nelles & Co., Leavenworth, Kans	12	$3,540	$42,480
2	Interstate Lumber Co., Chattanooga, Tenn	12	3,385	40,620
3	The Cincinnati Marine Rwy. Co., Cincinnati, Ohio	12	3,584	43,008
4	Louis H. Skinner, Wilmington, N. C	12	4,041	48,492
5	Ed. J. Howard, Jeffersonville, Ind	4 or 6	3,600	14,400 / 21,600
6	David S. Barmore, Madison, Ind	8	3,590	28,720

Available, $758,333.33; from appropriation of August 18, 1894.
No. 2 lowest; acceptance recommended.

Abstract of proposals for tow and dredge boat received in response to advertisement dated December 24, 1894, and opened January 23, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Amount.
1	Iowa Iron Works, Dubuque, Iowa	$35,000
2	M. A. Sweeney Co., Jeffersonville, Ind	31,300
3	Jas. Rees & Sons, Pittsburg, Pa	45,500
4	The Cincinnati Marine Rwy. Co., Cincinnati, Ohio	31,987
5	Ed. J. Howard, Jeffersonville, Ind	27,375

Available, $600,349; from appropriation of August 18, 1894.
Bid No. 5 the lowest; acceptance recommended.

* Of this amount $1,018,918.73 are at present available for works in progress, $31,100 being allotted for special work at Cape Girardeau and Cairo. The $8,746.74 remaining from the allotment of $50,000 for work at Ste. Genevieve made in the act of September 19, 1890, was expended during the past fiscal year in repairs to and extension of the work opposite Ste. Genevieve Landing at Little Rock, which was begun in 1891.

Abstract of proposals for piles received in response to advertisement dated December 31, 1894, and opened January 30, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	First class.							
		36 to 40 feet.		41 to 45 feet.		46 to 50 feet.		51 to 35 feet.	
		No.	Price per foot.	No.	Price per foot.	No.	Price per foot.	No.	Price per foot.
			Cents.		*Cents.*		*Cents.*		*Cents.*
1	C. C. Mengel, jr., & Bro. Co., Louisville, Ky	2,000	20	1,500	22	1,000	25	500	30
2	Fredk. Hartweg, Cincinnati, Ohio	2,000	9.50	1,500	9.50	1,000	9.50	500	9.50
3	St. Louis Refrigerator and Wooden Gutter Co., St. Louis, Mo	2,000	10.66	1,500	10.66	1,000	10.66	500	10.66
4	Berthold & Jennings, St. Louis, Mo	2,000	12.72	1,500	12.72	1,000	12.72	500	12.72

No.	Name and address of bidder.	Second class.					
		25 to 30 feet.		31 to 35 feet.		36 to 40 feet.	
		No.	Price per foot.	No.	Price per foot.	No.	Price per foot.
			Cents.		*Cents.*		*Cents.*
1	C. C. Mengel, jr., & Bro. Co., Louisville, Ky						
2	Fredk. Hartweg, Cincinnati, Ohio	1,000	6.75	4,000	6.75	5,000	6.75
3	St. Louis Refrigerator and Wooden Gutter Co., St. Louis, Mo	1,000	7.15	4,000	7.15	5,000	7.15
4	Berthold & Jennings, St. Louis, Mo						

No.	Name and address of bidder.	Second class.						Amount.
		41 to 45 feet.		46 to 50 feet.		51 to 65 feet.		
		No.	Price per foot.	No.	Price per foot.	No.	Price per foot.	
			Cents.		*Cents.*		*Cents.*	
1	C. C. Mengel, jr., & Bro. Co., Louisville, Ky							$50,090.00
2	Fredk. Hartweg, Cincinnati, Ohio	5,000	6.75	3,000	6.75	2,000	6.75	76,316.25
3	St. Louis Refrigerator and Wooden Gutter Co., St. Louis, Mo	5,000	7.15	3,000	7.15	2,000	7.15	82,187.25
4	Berthold & Jennings, St. Louis, Mo							27,666.00

No. 2 lowest; acceptance recommended.
Amount available, $581,666; appropriated by act of August 18, 1894.

Abstract of proposals for brush received in response to advertisement dated December 31, 1894, and opened January 30, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Brush.	Price per cord.	Amount.
		Cords.		
1	Fredk. Hartweg, Cincinnati, Ohio	30,000	$2.44	$73,200
2	James Short, St. Charles, Mo	30,000	2.78	83,400

All bids considered too high. Rejection recommended.
Amount available, $581,666; appropriated by act of August 18, 1894.

Abstract of proposals for stone received in response to advertisement dated December 31, 1894, and opened January 30, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Quantity offered.	Price.	Amount.	Mode of delivery.
		Cubic yds.	*Cents.*		
1	John Cleary, Chester, Ill.	10,000	58	$5,800	Delivered on Government barges at Chester, Ill.
2	Edward Hely, West Plains, Mo.	50,000	64	32,000	Delivered on Government barges at Government works, the United States to do the towing and charge contractor towage eight-tenths of a cent per yard per mile for upstream towage and four-tenths of a cent per yard per mile for downstream towage.
3	Bussen Bros., Oakville, Mo.	10,000	50	5,000	Delivered on Government barges at Quarantine, Mo.
4	John Burns, St. Louis, Mo.	30,000	45	13,500	Delivered on Government barges near Riverside, Mo.
5	James Short, St. Charles, Mo.	20,000	47	9,400	Delivered on Government barges 1 mile above Crystal City Landing, Mo.
6	Martin Lorenz, St. Louis, Mo.	30,000	54	16,200	Delivered on Government barges at foot of Cahokia street, St. Louis, Mo.

Acceptance recommended of bids Nos. 1, 3, and 4.
Amount available, $581,666; appropriated by act of August 18, 1894.

Abstract of proposals for steam pumps for tow and dredge boat received in response to advertisement dated January 30, 1895, and opened February 20, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Amount.
1	S. C. Forsaith Machine Co., Manchester, N. H.	$2,275 *4,275
2	Hooker Colville Steam Pump Co., St. Louis, Mo.	2,575
3	M. M. Buck Manufacturing Co., St. Louis, Mo.	4,725
4	Chas. W. Melcher Machine Co., St. Louis, Mo	†3,720 3,460 †2,956
5	Daniel Kelly, Philadelphia, Pa.	3,884
6	Barr Pumping Engine Co., Philadelphia, Pa.	3,600

*Increased by telegram. †By letter accompanying bid.

Award recommended to bid No. 2.
Amount available, $424,800; from appropriation of August 18, 1894.

Abstract of proposals for coal received in response to advertisement dated February 6, 1895, and opened February 26, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	30,000 bushels coal delivered on U. S. boats at U. S. engineer depot or elsewhere in St. Louis Harbor (per bushel)	50,000 bushels coal delivered on U. S. barges, the barges to be towed as specified (per bushel).	Amount.
		Cents.	*Cents.*	
1	Consolidated Coal Company of St. Louis, St. Louis, Mo..	7½	6½	$5,500

Only one bid received. Rejection recommended.
Amount available, $422,000; from appropriation of August 18, 1894.

Abstract of proposals for steam capstans with engines for tow and dredge boat received in response to advertisement dated February 6, 1895, and opened February 26, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Price (each).	Amount.
1	South St. Louis Foundry, St. Louis, Mo	$540	$2,160
2	Shoellhorn-Albrecht Machine Co., St. Louis, Mo	600	2,400
3	Fulton Iron Works, St. Louis, Mo	900	3,600
4	Geo. J. Fritz, St. Louis, Mo	682	2,728

No. 1 lowest; acceptance recommended.
Amount available, $422,000; from appropriation of August 18, 1894.

Abstract of proposals for rope received in response to advertisement dated February 6, 1895, and opened February 21, 1895, by Maj. Charles J. Allen, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	5,000 pounds pure manila rope, $\frac{3}{4}$ inch diameter.	15,000 pounds pure manila rope, $\frac{3}{4}$ inch diameter.	15,000 pounds pure manila bolt rope, 1 inch diameter.
		Cents.	*Cents.*	*Cents.*
1	Simmons Hardware Co., St. Louis, Mo	8	7$\frac{1}{8}$	9
2	Eagle Boat Store Co., St. Louis, Mo	7.46	6.96	8.21
3	M. M. Buck Manufacturing Co., St. Louis, Mo	7.49	6.97	8.49
4	Jas. J. Hawk, St. Louis, Mo	6.865	6.865	7.97 * 7.72
5	Harry E. Coffin, Memphis, Tenn	6$\frac{3}{4}$	6$\frac{3}{4}$	7$\frac{3}{4}$
6	H. L. Fox & Co., St. Louis, Mo	6$\frac{3}{4}$	6$\frac{3}{4}$	7$\frac{3}{4}$
7	Thos. S. Maxwell, St. Louis, Mo	7$\frac{1}{8}$	7	8$\frac{1}{8}$

No.	Name and address of bidder.	15,000 pounds pure manila bolt rope, 1$\frac{1}{4}$ inches diameter.	10,000 pounds pure manila bolt rope, 1$\frac{1}{2}$ inches diameter.	10,000 pounds pure manila bolt rope, 1$\frac{3}{4}$ inches diameter.	Total.
		Cents.	*Cents.*	*Cents.*	
1	Simmons Hardware Co., St. Louis, Mo	9	9	9	$6,025
2	Eagle Boat Store Co., St. Louis, Mo	8.21	8.21	8.21	5,522
3	M. M. Buck Manufacturing Co., St. Louis, Mo	8.49	8.49	8.49	5,665
4	Jas. J. Hawk, St. Louis, Mo	7.97 7.72	7.97 7.72	7.97 7.72	5,358 5,233
5	Harry E. Coffin, Memphis, Tenn	7$\frac{3}{4}$	7$\frac{3}{4}$	7$\frac{3}{4}$	5,225
6	H. L. Fox & Co., St. Louis, Mo	7$\frac{3}{4}$	7$\frac{3}{4}$	7$\frac{3}{4}$	5,225
7	Thos. S. Maxwell, St. Louis, Mo	8$\frac{1}{8}$	8$\frac{1}{8}$	8$\frac{1}{8}$	5,525

* Supplemental bid by letter accompanying bid.

Nos. 5 and 6 lowest; acceptance recommended of No. 5.
Amount available, $420,000, from appropriation of August 18, 1894.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., June 30, 1895.

MAJOR: I have the honor to submit the following report for the fiscal year ending June 30, 1895, upon the improvement of the Mississippi River between the Ohio and Missouri rivers, of which I have had supervision under your direction, including as part of it the reports of assistants in local charge.

A summary of the work that had been done by the United States at the several localities at the beginning of the fiscal year was given in the report of last year. See Annual Report of the Chief of Engineers, 1894, page 1577 et seq. Tables herewith submitted give the quantities of work in bank protection, dikes, dams, and hurdles, with areas reclaimed by the hurdles. Table No. 3 shows 59 miles of hurdles built and 22 miles of bank protected in carrying the improvement continuously down-

stream to Ste. Genevieve works, Missouri, a distance of 56 miles below Eads Bridge, St. Louis. Many of the works within this reach are incomplete and have been designedly left so to await results.

The protection of new banks, which has of necessity to follow their formation, can only be completed after the desired results shall have been obtained. By this sequence of work time becomes an important element in the improvement, and when considered in connection with a single locality where work has been in progress for several years the process may have a prima facie appearance of slowness. Fortunately, however, increased channel depths result from the works built during the earlier stages of the improvement.

During this year new work was prosecuted and additions, extensions, and repairs were made to old works at several localities in carrying the improvement continuously down stream, viz: Horsetail Bar, west side; Pulltight, Sulphur Springs, Fosters Island, Lucas, Cornice Island, Michaels, in Rush Tower reach; Fort Chartres, both sides; Turkey Island, Ste. Genevieve, both sides, and portable jetties were placed to hasten results at Fort Chartres, and for temporary relief to navigation at Devils Island.

Horsetail Bar.—The work at this locality was the continuation of the extension of the protection of the new bank formed on the west side of the river by hurdles which were built in 1881 and following years. It comprised fabricating and placing 290 linear feet of mattress below water surface at the stage prevailing during October, and stone revetment to the stage of 12 feet above standard low water upon the same frontage; this extended the bank protection up to Dike No. 1, where it connected with that previously placed, thus making the protection continuous from the head of the bank at the mouth of the river Des Peres to a distance of about 2,800 feet below Dike No. 1.

Pulltight.—At this locality the work for the year was in continuation of additions, extensions, and repairs begun in 1893 on the series of hurdles projected for its improvement. The buttresses on the river ends of Hurdles Nos. 0 and 1 were raised to the stage of 14 feet above standard low water by alternate layers of brush and stone, and buttresses of stone were built to the same elevation on the river ends of 0¼ and 2. This work places the series of hurdles as far as built in good condition to be efficient for the removal of the bars which formerly obstructed navigation. The results have been very satisfactory. Not less than 7¼ feet was found in the Pulltight crossing during this year where there was only 4½ feet during the year 1893.

Sulphur Springs.—This is one of the localities notable for shoal water before improvements were begun, and especially throughout the low-water season of 1894. The channel was difficult to navigate with tows on account of abrupt changes of direction and crossings from one side of the river to the other nearly at right angles to the axis of the stream.

The improvement was begun here during the fiscal year 1887, when a number of hurdles in the series were built. The work of this year was building additional hurdles; also extending and repairing those formerly built. On account of the low stage of water during this year all of the hurdles of this projected series could not be completed, but the work so favorably affected the channel, both in depth and direction, that its navigation is much less difficult. The hurdles built this year aggregate 7,595 feet in length, distributed on Nos. 3 to 18, inclusive.

Fosters Island.—The only work at this locality during the year was placing a section of mattress 100 feet in length, which had broken away from the hurdles at Sulphur Springs and revetting the bank above it. As placed, it forms part of an extension of the bank protection of 1882 to 1884, and which will be required for the completion of the island protection.

Lucas.—At this locality the work was in making additions, extensions, and repairs to the series built there from 1888 to 1890. The length of completed hurdle built during this year aggregated 150 feet, distributed on Hurdles Nos. 4½, 9, and 11, on which work was in progress at the close of the year.

Cornice Island.—At this locality work was begun June 1 on the construction of Hurdles Nos. 1, 2, 3, 4, and 5 proposed for its improvement and continued to the close of this year. The total length of hurdles built aggregated 2,510 feet.

Rush Tower Reach.—This reach formerly comprised several detached works between the head of Calico Island and Brickey's Mill, which were grouped together for purposes of administration, but during this year the division between the administrative reaches was made at Michaels, the head of the locality formerly designated, in distinction from other works within Rush Tower Reach, as "Hurdles on west side below Kennett's Castle," and the designation Michaels has been given it.

Michaels.—The work at this locality comprised the construction of Hurdle No. 1 and repairing, as far as practicable at the prevailing low stages of water, No. 3 of the projected series.

The location of No. 1 was changed by swinging its shore end about 1,500 feet upstream, leaving the other end unchanged, thus giving the line a direction inclined

downstream to Osborne Towhead, which was protected by mattress and revetment. On account of the exposed position of the hurdle 8 buttresses, spaced about 300 feet apart, were built 80 feet above the hurdle. In making the shore connection 4 piers of stone were built to the elevation of 16 feet above low water. Another pier will be required, and all of them should be raised to the height of the hurdle, to prevent a stream of water pouring around the shore end at high stages of river.

On Hurdle No. 3 the work was the completion of the repair of the piling in the west gap, which was in progress at the beginning of the fiscal year (see Annual Report of the Chief of Engineers for 1894, page 1605) and in building 9 stone piers to secure a connection with the rocky shore at the west end. The aggregate length of hurdle built was 3,250 feet.

Fort Chartres.—This is one of the localities notable for difficult navigation. Work for its improvement was begun in 1875, when a dam was partly built to close the chute west of Bruce Island, then known as Fort Chartres Towhead, after which no further work was done until the fiscal year 1893, when a series of hurdles was constructed during that and the following year, and the bank opposite was protected in part to a distance of 5,500 feet below Sycamore Landing.

The work of this year was the trimming of the piers on the rocky shore at the west end of the hurdles, the protection of the east bank of Bruce Island, and placing portable jetties to concentrate the current upon the narrow bar which still obstructed the navigable channel. The stone piers connecting the hurdles of the series west of Bruce Island with the rocky shore, which were built during high stages of water, were repaired by placing part of the stone to better advantage. The protection of the east bank of Bruce Island consisted in placing mattress 125 feet wide below water surface for a distance of 3,300 feet above the foot of the island and covering the space between the shore edge of the mattress and the foot of the abrupt bank with revetment.

Upon the approach of the low-water season, about September 1, a shoal with about 5 feet depth developed in the crossing of the bar nearly opposite Fort Chartres Landing. The channel above held close to the Illinois side of the river with a large body of water continuing down that shore until Crook's Landing below was reached, when it dispersed into several small channels, none of which were suitable for navigation, while the main or larger body spilled over the reef in a broad sheet to Bruce Island. In order to hasten the cutting of a channel through the reef, two portable jetties were placed so that they formed a funnel-shaped chute, which concentrated the flow upon the bar. The only channel practicable for navigation passed between the jetties, and as towboats could only make the crossing by flanking, the space between the jetties at the lower orifice could not be sufficiently reduced to obtain the full results desired. A narrow channel 9 feet deep was soon opened along the face of the lower jetty, but a bar which formed immediately below it concentrated the water which passed east of the jetties into a narrow stream along the upper face of the dry bar below, opening a channel 7 feet in depth, which was increased to 9 feet with ample width by the use of pile-driver jets.

These jetties were comparatively inexpensive, as they were improvised from plant and material used in carrying on the improvement; a small amount of grub plank was the only material purchased directly for the purpose. The work on the jetties was begun September 5, and they were removed on the 20th of the same month after the desired results had been obtained.

Turkey Island.—The work at this locality consisted in placing a mattress below water surface for the protection of 1,200 feet of the west face of the island, with stone revetment to the stage of 11 feet above standard low water. The work was in progress at the close of the fiscal year.

Ste. Genevieve.—This locality, extending from the foot of Turkey Island to Kaskaskia, comprises several series of hurdles and bank protection on both sides of the river projected for its improvement. The work of this year included the repair, as far as practicable, of the hurdles below the foot of Turkey Island, built in 1891 and 1892 in accordance with the project to prevent the channel leaving Little Rock, the landing for Ste. Genevieve, required by river and harbor act of 1890; the extension of this series, which has been included in the general project for the improvement of the river, down to the head of Moro Island; the protection of the west face of Moro Island on the Illinois side of the river; and the construction of a series of hurdles on the Missouri side at Stantons Landing.

The work was still in progress at the close of the year, when the hurdles constructed aggregated 6,575 feet, distributed on Nos. 4, 6, 8, 10, 12 and 15 on the Illinois, and Nos. 2 and 3 on the Missouri side of the river, and the bank of Moro Island was protected a distance of 5,700 feet by a mattress of the usual form placed below the water surface, with revetment above it to the foot of the abrupt bank.

Devils Island.—The only work at this locality was the placing of a portable jetty similar to those used at Fort Chartres in an attempt to increase the depth on the narrow bar, over which only 4 feet of water could be carried by steamers, and that

depth was found only in a channel which crossed the bar nearly at right angles to the axis of the river. The water was spread in a thin sheet from bank to bank of the river, with a depth of 2½ to 4 feet throughout its entire width of about 4,000 feet, without dry bars and with only small differences of depth or velocities of current, and without any well-defined indications that the channel would improve from the unaided efforts of the river.

The channel used by the steamers after crossing the Devils Island bar followed the Illinois side some distance below and crossed to Cape Girardeau from Wahoo, where there was another shoal, with little if any more depth than was found at Devils Island. There was, however, a tendency to form a channel crossing to Flora Creek on the Missouri side, leaving Devils Island above the bar, sufficient to induce several steamers to attempt a crossing, but up to the date on which work was begun no better channel had been found than that via Devils Island and Wahoo bars.

The crossing at Devils Island Bar was about 600 feet out from the island shore at the lower hurdle of the series built there in 1883. The portable jetty, 600 feet in length, was placed above this hurdle, and was inclined downstream from the shore to the best water, while pile-driver jets were used on the bar to aid in deepening the channel. A small gain in depth was made, but a steamer with its tow grounding in the channel flattened it out so that gain was lost. No appreciable benefit was obtained from the use of this jetty on account of the broad expanse of water, feeble current, and want of available plant to concentrate the flow. The barges being needed for other work, the jetty was transferred to piles driven for a support, and as the Mississippi River Commission had begun surveys and taken steps preparatory to operating the dredge *Experimenter* on the bar, the force used in connection with this work was withdrawn.

Plates.—For further information this report makes reference to plates numbered 1, 2, 3, 4, 5, and 6. Plate No. 1, on a scale of 1:100000, is a map of the river from the Missouri River to Big Eddy, 85 miles below Eads Bridge, showing the location of works in the reach under process of continuous improvement, with bars as they appeared upon the dates of the latest surveys and examinations available; for the part above the Merchants Bridge, St. Louis, from the Mississippi River Commission charts of 1879–1889, with sketches made last year above Sawyer Bend; between the Merchants Bridge and the southern limits of St. Louis, from the low-water survey by this office in 1894, with examinations recently made between the Merchants and Eads bridges; for the part between the southern limits of St. Louis and Kaskaskia River, from the low-water surveys of 1895, and for the part below the latter point, from the low-water survey of 1894.

Plates 2 to 6, inclusive, on a scale of 1:25000, shows the location and condition of the works June 30, 1895. The localities where the work has been prosecuted during this fiscal year are shown on the plates as follows:

No. 2. Horsetail Bar and Pulltight.
No. 3. Sulphur Springs and Fosters Island.
No. 4. Lucas and Cornice Island.
No. 5. Michaels and Fort Chartres.
No. 6. Turkey Island and Ste. Genevieve.

These plates also show works which have been projected and those previously built, together with bars, as they appeared upon certain dates and stages as noted thereon.

Procuring materials.—The brush required during the first half of the fiscal year, 10,749.1 cords, and 3,131.9 of the 25,754 cords required during the last half, was procured by hired labor. The remainder, 22,622.1 cords, was procured by contract from James Short.

The stone required was procured as follows: By hired labor, 34,792.6 cubic yards; purchased in open market upon bids, after legal notice, 9,187.1 cubic yards, and by contract with John Burns, 17,173.97 cubic yards.

Of the piles required, 7,497 were procured from the St. Louis Refrigerator and Wooden Gutter Company, 8,515 from Frederick Hartweg—both under formal contract—and 3,395 from John Cleary, in open market upon bids, after legal notice.

Other materials, including bolts, clevises, nails, rope, wire, spikes, and miscellaneous supplies, were purchased as required, usually in open market upon bids after legal notice, but were procured by contract whenever that method was most economical and advantageous to the Government.

Plant.—The plant at the beginning of this fiscal year, even with the additions provided for, was still insufficient for the proper expenditure of this and future appropriations, besides a number of the vessels had become unserviceable from age; therefore it was determined to increase the plant by 1 tow and dredge boat, 12 model barges, and 15 skiffs. The skiffs have been purchased under an informal contract, and the boat and barges are now in process of construction by contract—the boat with E. J. Howard, of Jeffersonville, Ind., and the barges with the Interstate Lumber Company, of Chattanooga, Tenn. The plant now available for service comprises

the following: 2 towboats, 7 steam tenders, 54 model barges, 35 pile drivers, 1 small machine-shop boat, 2 derrick boats, 1 steam derrick, 10 quarter boats, besides portable buildings for quarters and storerooms; 4 office and survey boats, 265 flats, and the necessary yawls, skiffs, tools, and appliances.

The towboat *Gen. Gillmore* was sunk by striking a hidden obstruction at Fort Chartres, and was thoroughly repaired on the marine ways of this city. Two pile drivers were sunk in front of the engineer depot by ice upon the breaking up of the gorges in February, and they were hauled out on the ways at the depot for repairs. Most of the vessels comprised in the plant are comparatively new and in good condition, except the hull of the towboat *Gen. Gillmore*, which was built twelve years ago, with the machinery much older; 16 model barges, which have been in service more than ten years, 5 of them fourteen years, and the machinery of 7 pile drivers, which has been in use fourteen years.

Engineer depot.—An important adjunct to the plant is the engineer depot, which comprises warehouses for the storage of subsistence supplies and the various materials used in connection with the improvement, blacksmith and carpenter shops, and a building yard with ways for use in construction and repair of barges and smaller vessels appertaining to the plant. It has a water frontage of about 900 feet available for care of vessels harbored there for repairs or other purposes.

During this year in the work of constructing, completing, outfitting, and repairing the plant, the towboats *Gen. Gillmore* and *Gen. T. L. Casey*, steam tenders, pile drivers, derrick boats, barges, quarter boats, office and survey boats, flats, skiffs, and yawls were overhauled and restored to serviceable condition as required.

Gauges.—Gauges were read under the direction of this office daily at Chain of Rocks, Bissells Point, Engineer Depot, Jefferson Barracks, Waters Point, Cornice Rock, Brickeys Mill, Little Rock, East Kaskaskia, Chester, Bishops, and Grays Point. The readings of these gauges and also the readings of the St. Louis gauge obtained from the Weather Bureau have been filed for use in determining the changes in stages and surface slopes resulting from the improvement of the river after their readings shall have been continued through a sufficient period.

The gauges show decided changes in stages and slopes on the portion of the river immediately below St. Louis now under process of improvement, but the extent of such changes resulting from the works can only be given after a long period of gauge observations.

Stages of water.—This year is remarkable for the low stages of water which prevailed. Beginning with 13 feet above standard low water July 1, the river fell to that stage by the last of August; a rise of 2 feet kept it above standard low water until the end of September, when it fell below and remained there until the opening of navigation, February 26. During the entire spring season the river remained unusually low, not exceeding the 6-foot stage above standard low water until June 13, when it rose to a 9-foot stage, which is 5 feet less than the minimum spring, generally called the June, rise recorded at St. Louis since 1861.

Condition of the river.—Prior to the beginning of this year the works for the improvement of the river continuously downstream from St. Louis had been well advanced to Fort Chartres, a distance of 47 miles below, and by the operations of this year this distance has been extended 9 miles farther downstream. Further work, however, will be required at most of the localities within this reach.

The navigable channel has been improved and the minimum depths have been considerably greater than prevailed within the same reach before the improvements began or than prevailed in the unimproved portion as far down as the Ohio River. The least depth found during this year in this reach, which formerly contained some of the shoalest bars between St. Louis and the Ohio River, was at Fort Chartres, where there was only 5 feet in the early part of September, but it was soon increased to 9 feet as the result of the improvement and the application of portable jetties. The depths below the portion of the river under process of improvement were no more than 4 feet at a number of points during the unusually low stage which prevailed from August to the close of the season's navigation in December.

Form of construction.—Hurdles in various modifications of form have been built in experimenting to determine which would secure the desired result at the least cost. A résumé of the forms of construction used at different times in connection with the improvement prior to the beginning of this year is given in the report for the fiscal year 1894. (See Annual Report of the Chief of Engineers for 1894, Appendix X 2, page 1577 et seq.)

The forms of hurdle used this year do not differ materially from those used last year, the essential features of a broad foundation mattress with piling driven centrally through it in form and height to resist the impact of ice and drift and to check the velocity of flow at all stages below that of flood are common to all of them, though details may be varied to suit particular cases. They may still be considered in the experimental stage, for although they have stood remarkably well, the absence of

floods or high stages when ice gorges were breaking prevented a severe test of their strength to withstand the forces which have tested other forms most severely.

The form of bank protection was the same as that used during the preceding year and described with an account of its development in the annual report above mentioned. It consists, essentially, of a mattress with its shore edge placed at the intersection of the water surface with the bank and extending into the stream 120 feet beyond the curve of standard low water, with a revetment of stone from the mattress to the top of the bank.

Accompanying reports.—Reference is made to the reports of assistants in local charge submitted herewith for further details. They are as follows: Report of Mr. Gerald Bagnall, assistant engineer, upon works at Horsetail Bar, Pulltight, Sulphur Springs, Fosters Island, Lucas, and Cornice Island; report of Mr. William S. Mitchell, assistant engineer, upon works at Michaels, in Rush Tower reach, Fort Chartres, Turkey Island, Ste. Genevieve, and Devils Island; reports of Mr. E. D. Libby, assistant engineer, upon brush and stone procured by hired labor; reports of Mr. John O. Holman, assistant engineer, upon gauges and works constructed; report of Mr. C. D. Lamb, superintendent, upon constructing, repairing, and outfitting the plant at the engineer depot.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER, ON WORKS AT MICHAELS LANDING, FORT CHARTRES, TURKEY ISLAND, STE. GENEVIEVE, AND DEVILS ISLAND.

STE. GENEVIEVE, MO., *June 30, 1895.*

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River within the reach below Michaels Landing during the fiscal year ending June 30, 1895:

For the first three months in the year work of construction, owing to lack of funds, was supended and the plant was in harbor at Rush Tower and Cornice Bluff.

During this time, however, considerable work of a minor and temporary character was done; 1,341 sticks of pile timber were received on an unexpired contract and were transferred to Government barges to be held for use on the resumption of active operations; a low-water survey was made from Foster Island to Kaskaskia to note changes in channel depths and in bar and shore lines; the Missouri shore opposite Chester was also surveyed to determine the amount of erosion (it was found to be very slight) during the preceding spring high water and an examination was made of Kaskaskia Chute. This chute was formerly the bed of the Kaskaskia River and at its head, near the town of that name, was crossed by a bridge long since destroyed. The piers of this bridge had been toppled over by the river or removed with the exception of that on the west bank, which at the beginning of the low-water season, in the latter part of July, became, by reason of the rapid erosion of the bank, dangerous to navigation. It was destroyed by dynamite and the main channel of the river now passes over its site.

The low water also developed two very shoal bars which became serious obstructions to navigation in September. These were at Fort Chartres and Devils Island.

At Fort Chartres the crossing over the reef next Bruce Island shoaled to 5 feet. An attempt to increase this was made by the construction of temporary dams so located as to concentrate into the crossing the flow over the bar. The first dam placed (September 5 to 8) was 600 feet in length, located 200 yards below the Island Light, with its ends in deep water, 8 feet and 12 feet, respectively, on the east and west sides of the bar. The dam consisted of five barges moored in line above clumps of piles, and over the upstream sides of the barges were hung close aprons or gates of 2-inch grub plank 16 feet long, each overlapping the next about 1 foot and wide enough to reach from the bottom to the water surface and heavily weighted with stone. A scour to 9 feet in depth by 30 feet in width was caused along the front of the jetty. There was a corresponding shoaling below the barges which protected a large area of the bar from the current, the latter being driven east of the dam to the lower dry sand bar. A second and similar jetty of four barges was placed above the crossing on the reef, parallel with the island shore, the two dams forming the sides of a wide funnel to concentrate the flow over the crossing. The scour along the second jetty was not as great as that near the lower line, and although the depth on the crossing remained at about 6 feet it did not increase beyond that. The space between the funnel sides was too great, being about 1,000 feet. This, however, could not be lessened without danger of collision from steamers and tows which in passing, owing to the obliquity of the current, were compelled to flank across the bar and to pass between the jetties.

East of the lower dam the channel increased rapidly in depth and crossed the reef near the shoulder of the dry bar below the end of the island. When 7 feet depth was obtained 4 pile drivers were placed at work jetting on the reef with their pumps and soon had a well-defined channel 9 feet in depth across it. The dams were then (September 20 to 24) removed, the pile drivers and barges being taken for similar work to Devils Island. The east channel was soon after marked and lighted by the Light-House Department, and continues in general use and is the best channel in the vicinity, being about 2 feet deeper than the upper crossing, and, although it has flattened out somewhat, it has ever since given greater depths than are found at other points.

The locations of the dams, directions, and depths of currents and channels are shown on the accompanying tracing.

At Devils Island the steamer crossing was about 600 feet out from the hurdle near the lower end of the island and had shoaled to 4½ and 5 feet. It was very short and almost at right angles with the axis of the main river, which is here very wide and shallow, spreading at low stages with feeble current over an enormous flat bar submerged from 2½ to 4 feet, there being no dry sand or ridge anywhere in the vicinity to concentrate the water into a channel.

A jetty or wing dam of barges and plank aprons was placed (September 24 to 27) in a line 700 feet long, sloping slightly downstream from the island shore above the hurdle to deep water. It was located on a shoal on which only 3½ to 4 feet of water was found. The pile drivers were also used to jet on the reef as at Fort Chartres, but owing to the feeble current no great gain in depth was made on the crossing, although a scour was effected along the line of the dam. The barges were afterwards removed (October 5 to 9), and in their stead piles were driven as supports for the plank aprons and the dam was permitted to remain during the rest of the season.

A number of steamers and barges were aground on the crossing in September and October, the bar proving a serious obstruction to navigation.

On October 11 the small force engaged on this dam was withdrawn, a survey of the bar and vicinity having been begun by the Mississippi River Commission by which the dredge *Experimenter* was to be placed at work.

Construction work was resumed October 1 at Rush Tower and Fort Chartres.

RUSH TOWER WORKS.

Hurdle No 1.—At the stage of river then prevailing (4 feet on St. Louis gauge) the line originally projected for this hurdle was partly across a dry bar and partly in such shoal water that pile drivers could not be floated. For this reason the west end of the hurdle was moved upstream 1,500 feet, making a diagonal line 3,000 feet long from the foot of the bluff at Michaels Landing to its original east end at Osborne Towhead. A minimum depth of 3 feet on this line was thus secured, which was thought sufficient, as the river was then very low and the usual October rise was expected. But the river continued to fall steadily until 2 feet on the gauge was reached and remained all season at an extraordinarily low stage (about 3 feet), so that the line was in great part in very shoal water and much difficulty and delay were occasioned. As the pile drivers could not get to the rear line to drive brace piles, for 1,250 feet of the line the piling was driven in two rows of staggered four-pile clumps. In this 1,250 feet about 700 feet had to be driven before the mattress was fabricated, as the depth was insufficient to float the drivers over a mattress. The remainder of the line was driven in four-pile clumps, spaced 9-foot centers, and doubly braced from three-pile clumps 25 feet back of them. The hurdle was built with an allowance of one pile per running foot of line. For a connection with the rocky shore four piers of stone, spaced 25-foot centers, were raised to the level of the 16-foot stage. One more pier and an increased height of all to the 22-foot level will be required at high water to complete the hurdle to the main bank.

To protect the line from ice there were built eight large buttresses of pile clumps and stone, spaced 300 feet between centers and 80 feet above the hurdle. These buttresses were founded on brush mattresses 110 feet wide by 130 feet long, lapping 10 feet on the hurdle foundation. The original plan was to fill in the buttresses with brush and stone, but, on account of scarcity of materials and the shortness of the season, only the front wedge of each was filled with stone to the 12-foot stage, and the remainder was filled to the water surface around each clump of piles. The details of a buttress are shown in the accompanying drawing.

To fix the outer end of the hurdle, Osborne Towhead was protected with a mattress and stone revetment to the 12-foot level from a point 200 feet below the hurdle, around the upper end of the towhead and along the entire length of its east side.

Hurdle No. 3.—The repairs to the piling, which were begun in June and were incomplete on the suspension of work in the summer, were finished, and for a shore connection nine stone piers, 25-foot centers and to the 22-foot level, were built.

The location of the works at Rush Tower with depths of channels and bar lines are shown on the chart.

FORT CHARTRES WORKS.

The stone piers forming the shore connections of the hurdles in this system were redressed and walled up in rough bond to prevent slipping under pressure from high water.

A low-water mattress was placed (October 2 to 31) to protect the rapidly caving east bank of Bruce Island. It was of the ordinary type, 125 feet in width, and extends 3,300 feet upstream from the lower end of the island. Between the shore edge of the mattress and the foot of the abrupt bank at the level of the 6-foot stage of river (St. Louis gauge) a space of an average width of 14 feet was revetted with stone. The bank above was not graded, but will be revetted after the action of the first high water.

The location of the mattress is shown in the accompanying chart.

All work for the fall season was completed November 27 and the plant was at once removed for the winter to the harbor in St. Marys Bend and to the engineer depot.

About 729 sticks of pile timber, delivered November 26 on the contractor's barges at the harbor, were transferred to Government barges.

The ice formed during the winter was unusually heavy, but fortunately on breaking up it passed out at a low stage of river (about 10 feet, St. Louis gauge) without the slightest damage to the works. The river remained at such a low stage during the spring that when operations were resumed the project for the reach near Ste. Genevieve was found to be the only one which could be advantageously begun. Accordingly work was begun (April 15) with the repair of Hurdle No. 4 above Mudds Landing and the construction of other hurdles in this series. As the new lines were to lie between the Illinois bank and a sand bar (dry at a 12-foot stage) protecting their outer ends, it was thought that the construction of the alternate lines, Nos. 6, 8, 10, 12 (spaced 2,000 feet apart), and No. 15, crossing Moro Slough, would secure such results as would render the remaining lines, in whole or in part, unnecessary. Hurdle No. 14 was omitted, as it was found to cross very deep water, necessitating the use of very long piles, and its site seemed protected by Nos. 12 and 15, but as it was at the upper end of the deep water along Moro Island shore the protection mattress for the island was moved up to that point.

Of the series of hurdles on the west side of the river it was decided to build all the lines (omitting only No. 1 as too short to be effective) abutting on the towheads in front of Ste. Genevieve.

EAST SERIES.

Hurdles Nos. 2 and 3.—These lines have collected large deposits about them which now form a continuous bar, dry at mean stages, with the lower end of Turkey Island. Both hurdles have been badly broken by ice, but on account of shoal water repair was not possible.

Hurdle No. 4.—This line was originally 950 feet in length, but the piling in its outer half has also been demolished by ice. The remainder of the hurdle was repaired and the piling restored for 300 feet with curtains to the 15-foot level. On account of shoal water nothing further could be done.

Hurdles Nos. 6 and 8.—These hurdles are 725 and 850 feet in length, respectively, and are completed.

Hurdle No. 10.—This line is 1,100 feet in length, and is complete, with the exception of the piling, for 300 feet across what has been throughout the season a dry bar. This portion will be driven at a higher stage of river.

Hurdles Nos. 12 and 15.—These lines are 1,550 and 1,150 feet in length and are also completed. The latter line is without ice buttresses, as its ends abut on the Illinois shore and Moro Island.

These hurdles are all of the same type. They are founded on woven brush mattresses 100 feet wide, extending from revetments of stone on the main bank to T-head mattresses at their outer ends. As the Illinois bank is here very firm, the stone revetments were not carried along the bank beyond the foundation mattresses and were raised from the mattresses to the foot of the abrupt bank only, or on those portions of the bank which had already assumed a suitable slope, no grading being done. In consequence the tops of the end revetments are at the levels of the following contours: No. 6, 17 feet; No. 8, 15 feet; No. 10, 18 feet; No. 12, 20 feet; No. 15, both ends 17 feet.

As the outer ends of Nos. 6 and 8 were so protected and in comparatively shoal water the T-head mattresses were made only 200 feet in length. The T-heads for Nos. 10 and 12 were made the usual 300 feet in length, and as the bank of Moro Island was sandy it was protected with a 300-foot shore mattress at the root of hurdle No. 15. This is, of course, the length of the revetment at this point.

The average allowance of piling for all these hurdles is one pile per linear foot of line. This proportion varies from one-half stick per foot in very shoal water to one

and a half sticks in deep, strong currents. The piles were driven in three or four pile clumps staggered in double rows, the top of each clump being bound with four turns of an 18-strand wire (No. 14) cable. In deep water, as at the outer ends of lines Nos. 10 and 12, the rows of clumps were strengthened by braces from a row of three pile clumps driven 25 feet below the main hurdle, each of the latter clumps supporting two braces. The outer ends of Hurdles Nos. 6 to 12, inclusive, are protected from above by ice buttresses similar to those built at Rush Tower and filled with brush and stone to the 15-foot level. The buttresses are immediately above the hurdle lines and are founded on the hurdle mattresses.

All the hurdles are screened with brush curtains to the 15-foot level.

WEST SERIES.

Hurdle No. 2.—The foundation and T-head mattresses have been placed as has also the shore-protection mattress, which was increased in length to 400 feet on account of the very soft character of the bank against which the hurdle abuts. This length of bank was graded by a water jet from a pile driver to a slope of 2 to 1 and was revetted with stone to the top.

Only a portion of the piling for this hurdle has been driven.

Hurdle No 3.—The foundation T-head and bank-protection mattresses have been placed, and about 500 feet of piling has been driven.

Hurdle No. 4.—The bank-protection mattress has been begun.

BANK PROTECTION.

Moro Island.—A protection mattress of the usual type has been placed (May 11 to June 25) along the west shore of this island from hurdle No. 14 to the bar below the steamer crossing. It is 5,700 feet in length by 127 feet in width, and was built in thirty-eight working days. Between the inner edge of the mattress and the foot of the abrupt bank at about the level of the 10-foot contour, a space averaging 20 feet in width with very flat slope, a layer of spalls 12 inches thick has been placed for the full length of the mattress. This will prevent cutting at high water along the foot of the bank behind the mattress and will afford a good footing for the riprap which is to be placed after the bank has been graded by the action of the river.

Turkey Island.—On June 14 the construction was begun of a protection mattress for the west bank of this island. The head of the mattress was placed about opposite White Sand Depot, at the upper end of the deep water along the shore.

As the delivery of brush has been slow, only a small force has been engaged, and but 1,200 feet of the 5,000 feet contemplated have been completed.

The locations of all the works are shown on the accompanying charts, and the following tables give the amounts of the work done, the expenditures of materials, and the service of equipment at each locality.

Considerable delay has been occasioned this spring by the slow delivery of pile timber and brush by the contractors.

Throughout the entire year the river has been almost unprecedently low. This, during the fall, made navigation extremely difficult and hazardous, but the prolonged low water during the winter cut out a well-defined channel in which the entire flow has been concentrated since the opening of navigation in the spring, and the depths obtained have been remarkably good for the stages of river prevailing. Especially has this been the case throughout those portions of the river under process of improvement.

TABLE NO. 1.—*Portable jetties located at Fort Chartres and Devils Island.*

	Fort Chartres.	Devils Island.	Total.
Length ..... feet..	900	700	1,600
Piles:			
Driven ..... number..	30	25	55
Penetration ..... feet..	550	440	990

TABLE NO. 2.—*Work done at Rush Tower Works.*

	Hurdles.		Total.
	No. 1.	Repairs of No. 3.	
Hurdles.....linear feet..	3,000	250	3,250
Piles:			
Driven.....number..	3,776	306	4,082
Penetration.....feet..	59,201	4,337	63,538
Braces.....number..	429	3	432
Foundation mattress, including T-heads.....linear feet...	3,951	.....	3,951
square feet..	422,090	.....	422,090
Protection mattress, east side Osborne Towhead.....linear feet...	1,025	.....	1,025
square feet..	126,407	.....	126,407
Stone revetment, east side Osborne Towhead.....linear feet...	1,037	.....	1,037
square feet..	23,164	.....	23,164
Ice buttresses.....number..	8	.....	8
Piers, shore connection.....do....	4	9	13

TABLE NO. 3.—*Work done at Bruce Island, bank protection.*

	Linear feet.	Square feet.
Protection mattress.....	3,276	404,817
Revetment above mattress.....	3,276	46,200

TABLE NO. 4.—*Work done at Turkey Island, bank protection.*

	Linear feet.	Square feet.
Protection mattress.....	1,200	152,400
Revetment above mattress.....	600	12,000

TABLE NO. 5.—*Ste. Genevieve works, hurdles, east series.*

	Repair and restoration No. 4.	No. 6.	No. 8.	No. 10.	No. 12.	No. 15.	Total.
Hurdles, equivalent....linear feet..	300	725	850	900	1,550	1,150	5,475
Piles:							
Driven.....number..	259	856	996	790	1,595	1,007	5,503
Penetration.....feet..	4,215	14,546	15,344	12,704	26,109	16,559	89,477
Braces placed.....number..	.....	.....	.....	48	.....	.....	48
Foundation mattress, { linear feet...	.....	836	1,056	1,398	1,855	1,315	6,460
including T-heads.. { square feet..	.....	83,600	105,600	136,910	185,500	131,500	643,110
Curtains.....linear feet..	773	705	850	800	1,550	1,150	5,828
Revetment, shore { .....do....	.....	100	100	100	100	300	700
ends..... { square feet..	.....	1,800	1,500	2,300	3,500	10,500	19,600

TABLE NO. 6.—*Ste. Genevieve works, Moro Island bank protection.*

	Linear feet.	Square feet.
Protection mattress.....	5,700	723,900
Revetment above mattress.....	5,700	114,000

TABLE NO. 7.—*Ste. Genevieve works, hurdles, west series.*

	No. 2.	No. 3.	No. 4.	Total.
Hurdles, equivalent.....linear feet..	350	750	.....	1,100
Piles:				
Driven.....number..	50	443	.....	493
Penetration.....feet..	816	8,329	.....	9,145
Foundation mattress, including T-heads.....{linear feet...	1,560	1,497	(*)	3,057
{square feet..	170,000	164,000	.....	334,000
Bank graded.....{linear feet...	400	.....	.....	400
{square feet..	14,000	.....	.....	14,000
{cubic yards..	4,500	.....	.....	4,500
Revetment, shore ends.....{linear feet...	400	.....	.....	400
{square feet..	16,000	.....	.....	16,000

*Begun.

TABLE NO. 8.—*Summary of work done during fiscal year ending June 30, 1895.*

	Fort Chartres and Devils Island.	Rush tower.	Bruce Island bank protection.	Turkey Island bank protection.	Ste. Genevieve works. Hurdles, east series.	Ste. Genevieve works. Moro Island bank protection.	Ste. Genevieve works. Hurdles, west series.	Total.
Wing dams.....linear feet..	1,600	.....	.....	.....	.....	.....	.....	1,600
Hurdles, equivalent.....do....	.....	3,250	.....	.....	5,475	.....	1,100	9,825
Piles:								
Driven.....number..	55	4,082	.....	.....	5,503	.....	493	10,133
Penetration.....feet..	990	63,538	.....	.....	89,477	.....	9,145	163,150
Braces.....number..	.....	432	.....	.....	48	.....	.....	480
Foundation mattress, including T-heads. {linear ft..	.....	3,951	.....	.....	6,460	.....	3,057	13,468
{square ft..	.....	422,090	.....	.....	643,110	.....	334,000	1,399,200
Curtains.....linear feet..	.....	.....	.....	.....	5,828	.....	.....	5,828
Protection mattress {.....do....	.....	1,025	3,276	1,200	.....	5,700	.....	11,201
{square ft....	.....	126,407	404,817	152,400	.....	723,900	.....	1,407,524
Bank graded.....{linear feet..	.....	.....	.....	.....	.....	.....	400	400
{square ft..	.....	.....	.....	.....	.....	.....	14,000	14,000
{cubic yds..	.....	.....	.....	.....	.....	.....	4,500	4,500
Stone revetment placed {lin. ft..	.....	1,037	3,276	600	700	5,700	400	11,713
{sq. ft..	.....	23,164	46,200	12,000	19,600	114,000	16,000	230,964

Very respectfully, your obedient servant,

WM. S. MITCHELL, *Assistant Engineer.*

Maj. CHAS. J. ALLEN,
Corps of Engineers.

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER, ON WORKS AT HORSETAIL BAR, PULLTIGHT, SULPHUR SPRINGS, FOSTERS ISLAND, LUCAS AND CORNICE ISLAND.

CORNICE ISLAND, MISSOURI, *June 30, 1895.*

MAJOR: I have the honor to make the following report of operations at Horsetail Bar, west, Pulltight, Sulphur Springs, Fosters Island, Lucas and Cornice Island for the fiscal year ending June 30, 1895.

The plant which had been employed at Horsetail Bar, east, in the spring of 1894 remained in harbor at Kimmswick, Mo., from July 1 to September 30, 1894. During that time the force employed on the fleet, besides their regular duties of watching and caring for the plant, were occupied in transferring piles from the contractor's barges to Government barges and in assisting to calk such boats as needed it. The office force was employed during that period in making and plotting surveys and in making detail drawings of the different methods employed in the construction of hurdles.

On October 1, 1894, work was commenced at Sulphur Springs and continued until the close of the season. Work was carried on at Horsetail Bar, west, from November 10 to the close of the season, and at Pulltight from October 10 to November 10, 1894. On April 15, 1895, operations were resumed at Sulphur Springs and continued until June 30, 1895. On May 18 a small piece of mat was placed on Fosters Island as bank protection. On May 17 a shore mat was placed on Hurdle 4½ at Lucas. On May 25 work was commenced at Cornice Island and continued to the end of the fiscal year.

WORK DONE.

Horsetail Bar, west.—Two hundred and ninety linear feet of bank protection was completed immediately below Dike No. 1. This was carried up the bank to about a 16-foot stage. (See Plate II.)

Pulltight.—The buttresses on lines Nos. 0 and 1 were raised to an 18-foot stage by alternate layers of brush and stone. Buttresses were constructed on the outer ends of lines 0½ and 2 and carried to an 18-foot stage. (See Plate II.)

Sulphur Springs.—Hurdles 5½, 6½, 8, 8½, 10, 10½, 12, and 17 were finished and all curtained except Hurdle 17, where the depth of water made it advisable not to curtain. Hurdles 3½ and 13 were nearly completed. Hurdles 14, 15, and 15½ were commenced, but could not be completed without encroaching upon the steamboat channel. At Hurdle 18 the shore mat was built and sunk. (See Plate III.)

Fosters Island.—One hundred feet of bank protection was placed on the upper end of the island and carried to about a 16-foot stage. (See Plate III.)

Lucas.—Hurdles 4½, 9, and 11, were commenced. On Hurdle 4½, 170 feet of mattress, which had broken loose at Sulphur Springs, was floated into position and sunk as a shore mat. (See Plate IV.)

Cornice Island.—Hurdles 2, 3, 4, and 5 were nearly completed and Hurdle No. 1 commenced. (See Plate IV.)

Class of hurdles constructed at Sulphur Springs.—Hurdles 3½, 6½, 8½, 10½, and 15 were braced diagonally with two braces to each clump. The outer ends of Hurdles 8, 10, 12, 15½, and 17, and the inshore end of Hurdle 13, were also braced diagonally. The outer half of Hurdles 12 and 17 were strengthened by a second row of clumps driven close behind the upper row, on account of their exposed position and the strength of current prevailing there. Where diagonal braces were placed behind a strengthened hurdle, as on the extreme outer ends of 12 and 17, the braces were bolted to the lower row of clumps. The outer ends of Hurdles 6½ and 12 were protected by buttresses built to a 20-foot stage and on the outer end of Hurdle 8½ a buttress was commenced but only completed to an 18-foot stage. The shore at the ends of all the hurdles was protected from cutting by a shore mat 300 feet long above which revetment was placed to such heights as the stage of river would admit without excessive cost.

METHODS OF CONSTRUCTION.

The methods of construction employed were the same as those described on pages 1596 to 1598, Report of Chief of Engineers for 1894.

RESULTS AND OBSERVATIONS.

There was a good navigable channel between St. Louis and Michaels Landing during the low-water season of 1894. While there has been considerable deposit at the different localities, the excessively low stage of river since the opening of the spring season has prevented results which might have been expected had the river reached its usual height. The chief deposits during the fiscal year have been at Horsetail Bar, east, Carrolls Island, and Twin Hollows.

During the seasons of the fall of 1894 and of the spring of 1895 work was retarded by the low stage of river, which interfered seriously with the procuring of material.

PLANT.

The new pile drivers have continued to do very effective work both as regards the number of piles driven and the penetration obtained. A third steam tender was added to the plant employed during the year and has greatly helped to expedite the work. The old quarter barges with portable shanties which remained in service at the end of the fiscal year ending June, 1894, have been replaced by large quarter boats, tending to increased comfort and better health of the men.

TABLE NO. 1.—*Showing work done at Horsetail Bar, west, and at Pulltight, during the fiscal year.*

HORSETAIL BAR, WEST.

Bank protection:	Square feet.
Mattress constructed and sunk, 40 by 100 feet; 250 by 115 feet	32,750
Revetment placed	31,707

PULLTIGHT.

Buttress constructed at Hurdle—	Cubic yards.
No. 0	1,352
No. 0½	2,318
No. 1	773
No. 2	2,318
Total	6,761

TABLE NO. 2.—*Showing work done at Sulphur Springs, Ill., during fiscal year.*

	At Hurdle No.—							
	3½.	5½.	6½.	8.	8½.	10.	10½.	12.
Hurdles constructed...linear feet..	400	420	440	570	640	675	930	1,000
Hurdles braced.....do....	400	.....	440	80	550	160	730	230
Hurdles strengthened.....do....	.....	.....	.....	.....	.....	.....	.....	450
Hurdles rebuilt.....do....	.....	.....	.....	.....	.....	.....	.....	.....
Foundation mattress constructed and sunk.....do....	985	880	1,041	790	805	940	1,455	1,578
	100,880	90,720	101,633	88,480	90,160	105,280	161,040	161,376
Shore mattress constructed and ballasted.....lin. ft.	.....	.....	.....	.....	.....	.....	.....	108
	.....	.....	.....	.....	.....	.....	.....	5,508
Buttress constructed and ballasted.....cubic yards..	.....	.....	3,663	.....	3,543	.....	.....	4,193
Revetment at end of hurdle.sq. ft..	30,178	10,458	23,476	16,480	16,008	25,638	16,660	9,290
Curtain constructed...linear feet..	380	380	345	555	575	630	870	885
Earth excavation....cubic yards..	.....	370	.....	800	.....	.....	.....	.....
Piles driven.....number..	325	292	463	439	716	573	847	852
Braces placed.....do....	98	.....	104	14	158	46	175	54
Stringers placed.....do....	.....	.....	.....	.....	.....	.....	.....	.....

	At Hurdle No.—						Total.
	13.	14.	15.	15½.	16.	17.	18.	
Hurdles constructed...linear feet..	870	150	260	435	.....	700	.....	7,490
Hurdles braced.....do....	300	.....	150	175	.....	200	.....	3,415
Hurdles strengthened.....do....	.....	.....	.....	.....	.....	200	.....	650
Hurdles rebuilt.....do....	.....	60	45	.....	.....	.....	.....	105
Foundation mattress constructed and sunk.....do....	1,260	415	554	945	300	1,320	355	13,628
	131,520	36,880	52,448	88,720	29,280	143,040	39,760	1,421,217
Shore mattress constructed and ballasted.....lin. ft.	.....	.....	.....	.....	.....	.....	.....	108
	.....	.....	.....	.....	.....	.....	.....	5,508
Buttress constructed and ballasted.....cubic yards..	.....	.....	.....	.....	.....	.....	.....	11,399
Revetment at end of hurdle.sq. ft..	13,118	11,968	17,198	25,848	.....	2,688	14,660	234,028
Curtain constructed...linear feet..	.....	.....	.....	.....	.....	.....	.....	4,620
Earth excavation....cubic yards..	1,200	150	.....	.....	.....	.....	880	3,400
Piles driven.....number..	585	117	224	315	24	534	9	6,315
Braces placed.....do....	75	.....	40	44	.....	35	.....	843
Stringers placed.....do....	.....	.....	.....	.....	.....	9	.....	9

TABLE NO. 3.—*Showing work done at Fosters Island and Lucas during the fiscal year.*

FOSTERS ISLAND.

Bank protection:		
Mattress constructed and sunk	linear feet...	100
	square feet..	11,200
Revetment placed.....do.....		4,851

LUCAS.

		At hurdle No.—			
		4½.	9.	11.	Total.
Hurdles constructed.....linear feet..		.....	.....	150	150
Foundation mattress constructed and sunk	.....do....	170	.....	865	1,035
	square feet..	19,040	.....	85,300	104,340
Piles driven.....number..		.....	31	95	126

TABLE NO. 4.—*Showing work done at Cornice Island, Missouri, during fiscal year.*

	At Hurdle No.—					Total.
	1.	2.	3.	4.	5.	
Hurdles constructed.....linear feet..	180	540	635	515	640	2,510
Foundation mattress constructed and sunk.....do....	995	1,020	910	1,085	1,090	5,100
	104,880	114,240	97,920	116,720	116,200	549,960
Buttress constructed and ballasted..cubic yds..	.....	.....	.....	1,733	.....	1,733
Revetment at end of hurdle.....square feet..	1,500	19,600	.....	.....	7,650	28,750
Curtain constructed.....	linear feet...	.....	.....	.....	400	400
	square feet..	.....	.....	.....	7,200	7,200
Piles driven.....number..	100	391	417	311	401	1,620

Very respectfully, your obedient servant,

GERALD BAGNALL, *Assistant Engineer.*

Maj. CHAS. J. ALLEN,
Corps of Engineers.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT, ON OPERATIONS AT U. S. ENGINEER DEPOT.

UNITED STATES ENGINEER DEPOT,
St. Louis, Mo., June 30, 1895.

MAJOR: I have the honor to submit the following report of operations at the engineer depot during the fiscal year ending June 30, 1895:

The force employed during July and August was small, being only that required to care for the property on hand and handle the stores and material received, but early in September the repairing of plant for use during the fall season was begun with a force consisting of 60 carpenters and calkers and 35 laborers. This force was reduced as repairs were completed; but a few were retained, with the 5 machinists and 2 blacksmiths, through the winter, employed in constructing and repairing the plant for use in the spring. The force was again increased in the spring, and all floating equipment calked as required for use. The employees retained at the close of the year included only those required for needed construction and those employed in handling the supplies received and shipped.

The work done upon plant during the year, as in former reports, is divided into three classes—construction, extraordinary repairs, and ordinary repairs.

There was also considerable work done on material besides the labor employed in handling supplies shipped to the construction works below.

CONSTRUCTION.

Tenders.—Steam tenders Nos. 5, 6, and 7 were received on July 4. They were provided with reels, racks, coal bunkers, etc., and sent out for service when needed for construction work in September.

Pile drivers.—The old pile drivers Nos. 1 to 6, retired during 1893, were replaced with new drivers bearing the same numbers.

These were built on six of the Cincinnati hulls with extra heavy hoisting engines, having 7 by 10 inch cylinders, and 14-foot boilers, 42 inches diameter, with four 10½-inch flues. Nos. 4, 5, and 6 were built with steel leads of the pattern described in previous reports, but Nos. 1, 2, and 3 with yellow pine leads, 8 by 12 inches by 42 feet high. No. 2, however, was damaged by the ice in February, and the hull was replaced by another having steel leads of the usual pattern.

The machinery for use in replacing that retired from pile drivers Nos. 16, 17, and 18 was received and placed aboard the hulls on which it will be used, and the leads and sills were set up on Nos. 16 and 17.

Barges.—Another hatch was cut in each end of barges Nos. 101 to 138, and hoods placed over both hatches at each end to turn fresh air into their holds.

Quarter boats.—Quarter boats Nos. 7, 8, 9, and 10 were supplied with cross bulkheads in the dining room, swinging fenders, pumps, lockers, bunk ladders, galvanized ventilating pipes running into the holds, and hatch hoods, and sent out for service as required.

Office and survey boats.—Boat No. 4 was provided with iron pumps and hatch hoods, and made ready for service.

Small boats.—Twenty-four decked flats were equipped with ways, and twelve of them with capstans. Ten open flats were decked. Fifteen new skiffs were painted.

Tools and appliances.—Fire tools, spanners, etc., were made for 12 pile drivers. Other tools were made as required, including 20 sets of mattress chains, 268 capstan bars, 4 calking flats, 50 life floats, 50 pikes, 100 pump boxes, 12 jackscrews, and 150 stage planks.

Boarding outfit.—Tables, benches, and clothes boxes were constructed for use on quarter boats Nos. 7 to 10, comprising 77 tables, 200 benches, and 24 boxes.

Portable jetties.—Two hundred gates for portable jetties were made during the spring for use during low water, each 10 by 10 feet, of No. 16 corrugated iron riveted to three unequal leg angle irons, each 3 by 5 by 5-16 inch and 16 feet long.

EXTRAORDINARY REPAIRS.

Towboat Gen. T. L. Casey.—The steam capstan purchased during the last fiscal year was fitted to its place on the boat. The bulkheads were changed to allow space for a kitchen upstairs and to give more room for coal on deck.

Towboat Gen. Gillmore.—The steamer *Gen. Gillmore* was docked at Carondelet after being sunk during October, and repairs upon her hull completed at this place during November. The work done here consisted in renewing the deck, nosing, and plank-sheer forward, calking the deck, topsides, and outriggers, and relaying the brick in the furnace.

Steam tenders.—A new steam capstan was purchased and set up on tender No. 3.

Pile drivers.—Extensive repairs were made to pile drivers Nos. 7, 10 and 15 during the fall, the cabins being rebuilt and new leads set up complete. These leads were of yellow pine, like those of No. 1, but the sills, braces, and chocks were of iron.

Barges.—The barges built in 1885, Nos. 1, 2, 3, 5 to 9, and 30, were pulled out upon the ways and extensively repaired. The work done was about the same on each barge, and consisted in renewing the rotten plank in the bottom and lower sides, calking the butts and new work, sheathing the decks with inch boards, and renewing the bitts, kevels, timber heads, nosing, and plank-sheer.

Quarter barges.—Quarter barge No. 27, which was on the ways at the beginning of the year, was calked and launched.

The quarter barges built in 1885, Nos. 4, 11, 28, and 29, were docked and repaired to the same extent as the barges built at the same time. The portable buildings were removed from No. 9, and it was sent out for service as a barge.

Small boats.—Eighteen skiffs were repaired with new sides of California redwood.

ORDINARY REPAIRS.

When work was resumed for the fall season the entire floating plant was calked and prepared for service, except a few small boats on the bank at this place. A part of this work was performed at the yard and a part at the works below by a force sent down for that purpose.

The same repairs were repeated in the spring, partly at the depot and partly at the winter harbor.

In addition to the above, small repairs were made at the depot, as follows:

Towboat Gen. T. L. Casey.—Small repairs were made to the escape pipe and furnace of the boat, and nine of the swinging fenders were renewed.

Towboat Gen. Gillmore.—The escape pipe and five fenders were renewed.

Steam tenders.—Small repairs were made as required upon the hulls and machinery of all the tenders, No. 3 being pulled out upon the ways, the knuckle seams calked, and the rudders repaired during the fall and again in the spring, when the rudder posts were entirely renewed and the furnace repaired.

The Providence capstan was taken out of No. 4 and replaced by that from the steamer *Gen. Casey.*

Tenders Nos. 1, 2, 6, and 7 were pulled out upon the ways late in the fall and kept there until work was resumed in the spring, when they were thoroughly repaired and made ready for service.

Pile drivers.—Small repairs were made during the fall season upon the leads of Nos. 11 and 20 and the engines of Nos. 14 and 25.

Three of the pile drivers at the depot were damaged by the ice during the breakup of the latter part of February; the gunwales of Nos. 2 and 6 were broken, and No. 15 was crowded out on the bank and the hull twisted. No. 15 was docked and calked. The machinery of Nos. 2 and 6 was set up on other hulls, and the damaged hulls were pulled out and repaired. They will be used in rebuilding Nos. 17 and 18.

Repairs were made upon the ironwork of drivers Nos. 25 to 35, consisting of new chocks, side braces, winch heads, sheave boxes, etc., and a new lead was set up on driver No. 29.

Derrick boats.—Small repairs were made upon the braces of both Nos. 1 and 2.

Barges.—Besides the calking at the beginning of the fall and spring season, small repairs were made as required upon Nos. 101 to 113.

The temporary quarters were removed from Nos. 1, 3, and 5 and the portable buildings from No. 9, and they were put back into service as barges.

Quarter boats.—The roofs of Nos. 1 to 7 were painted, the stovepipes riveted together, and small repairs made to the cabins and fenders.

Machine shop.—The machine shop was provided with a new roof in the fall. It was pulled out upon the ways during the winter, and is now blocked up on the bank.

Small boats.—All of the flats used during 1894, except 79, and all of the yawls and skiffs except 3, were pulled out upon the bank and piled up for the winter.

One hundred and forty-one flats, 54 skiffs, and 12 yawls were calked and sent out for service in the spring.

Tools and appliances.—Tools of all kinds were repaired as required during the year, the largest items of this kind being wheelbarrows, blocks, trucks, etc.

Boarding outfit.—All the ice boxes in use were rebottomed during the spring and the discharge pipes repaired. The large ice boxes on pile-driver hulls were removed and set up on quarter barges Nos. 11 and 28.

Boarding outfit of all kinds was repaired as required.

Engineer depot.—The shipping platform was extended 60 feet to the city wharf line during the low-water season and clumps of piles were driven along the front for moorings.

List of steamers and barges permanently and temporarily enrolled at the port of St. Louis on December 31, 1894.

	Vessels.	Gross tonnage.	Net tonnage.
Permanently enrolled:			
Steam (wood)	97	36,275	35,704.95
Barges (wood)	88	81,124.79	81,033.95
Steam (iron)	4	1,690.29	1,639.82
Temporary steamers (wood)	1	654.38	594.50
Permanently licensed:			
Steam, under 20 tons	7	132.62	96.62
Barges, under 20 tons	2	27.79	27.79
Yachts, under 20 tons	1	5.24	5.24
Grand total	200	119,910.11	119,102.87

W 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

St. Louis Harbor has a length of about 18 miles, being divided into two nearly equal parts by the Eads Bridge. The upper portion of the harbor, between this bridge and the northern limits of the city, is about 10 miles in length. About 3 miles above the Eads Bridge is the Merchants' Bridge. The lower portion of the harbor, included between the Eads Bridge and the River Des Peres, is about 8 miles long. A good depth of water and accessible landings exist in this lower part of the harbor, and a sufficient depth is found above the Merchants' Bridge.

Between the Merchants' and Eads bridges there had existed for a considerable number of years middle bars, and also shoals near the Illinois shore, which interfered with navigation, and which will be mentioned again further on.

Appropriations for improvement of St. Louis Harbor had been made as early as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work, done in later years by the United States, consisted in the building of stone and brush dikes generally normal to the direction of the current, in the closing of Cahokia Chute, and protection of the bank in Sawyer Bend.

The river and harbor act of Congress approved September 19, 1890, contained an appropriation of $182,000 for improving harbor at St. Louis, Mo., and the officer in charge, in submitting a project for its expenditure, recommended that the money be applied to the portion of the harbor between the Eads and Merchants' bridges. The approved project consisted in contracting this portion of the river to a width of about 2,000 feet by means of a system of hurdles built along the Illinois shore for a distance of about 13,000 feet, with a view to removing the bars which then existed and which interfered with navigation at low stages of the river, and also to improve the ferry landings on the Illinois shore. The object of the hurdles was to cause deposits of sediment, and thus build up a new bank out to the line desired. They were twelve in number and spaced 1,000 feet apart. The hurdles were from 325 to 2,075 feet in length each, and were constructed as follows:

The piles were driven in two rows 20 to 27 feet apart, the distance varying with the depth of water. The upper or drift row was composed of three pile clumps spaced 12 feet apart, with a stringer bolted to them on the downstream side. The piles in the lower or hurdle row were driven 6 feet apart, with a stringer bolted to them on the upstream side.

Brace piles for this row were driven every 12 feet, with their tops bolted to the stringer. The river ends of the hurdles were further strengthened by cross stringers bolted to the stringers of each row.

The drift row was carried to the 25 and the hurdle to the 20 foot stage above low water at St. Louis, rising, however, with the river above the 20-foot stage. For a length of 1,900 feet at the shore ends of Nos. 1, 9, 10, and 11 only the hurdle row was driven, the depth of water not requiring the drift row.

The woven foundation mattress of willows was 65 feet in width, extending that distance below the drift row, by which it was supported during construction. It was placed before the hurdle row was driven. Mattresses 200 feet long by 80 in width were placed at each end of the hurdles for protection against scour. Riprap was also used at the shore ends. Wattling the hurdle row with willows and sinking the drift wood where collected completed the construction of the hurdles.

The hurdles, which were built in depths of 2 feet to 36 feet of water, were all completed by July 1, 1892, the amount expended to that date having been $150,530.21. The extent of accretion produced by the hurdles may be judged by the following:

Soundings taken June, 1892, showed a fill of 8 feet by a width of 400 feet at No. 1 hurdle, 15 feet by a width of 600 feet at No. 6 hurdle, 10 feet by a width of 600 feet at No. 11 hurdle, or an average of about 12 feet over an area of about 160 acres.

The filling has increased yearly. By December, 1893, it covered the outer half of the areas inclosed by the hurdles; the depth of fill at No. 1 was 10 feet; at No. 11, 15 feet; between hurdles 6 and 7 it was 26 feet. The areas near to the original shore line had also been filled, but not to such an extent as had the outer areas.

The navigable depth in the channel of the harbor between the line of hurdles and the opposite wharf line of St. Louis was, in December, 1893, 11 feet when the river stood at zero on the gauge, and which stage is 4 feet below standard low water.

The amount expended to July 1, 1894, was $150,762.03.

There was no expenditure during the past fiscal year.

The fill over the area inclosed by the hurdles has been increased during the fiscal year ending June 30, 1895, by a deposit averaging a foot or more in depth. The heaviest deposit occurred on the ridge along the river end of the hurdles, and very little, if any, in some of the low places along the main shore at the lower end of the works.

The hurdles remain in fair condition except the extreme river end of the upper ones, which are unprotected by a deposit. These ends are weakened each year by drift during the high stages of the river and by the gradual decay of the pile timber, and will need some repairs at an early day.

The steamboat channel April 20 last ranged from 12 to 24 feet in depth with the river at a 7-foot stage. As the stage of water lowers the channel will probably cut out.

With the balance ($31,007.93) remaining from the appropriation of 1890 it is proposed to repair damage that may have occurred to the hurdles and to extend them when necessary so far as the funds will admit of doing.

No further appropriation is asked for this work.

The commercial statistics pertaining to amount of commerce and navigation benefited by this work will be found in the annual report on improvement of the Mississippi River between the mouth of the Ohio River and the mouth of the Missouri River.

Money statement.

July 1, 1894, balance unexpended	$31,237.97
July 1, 1895, balance unexpended	31,237.97
July 1, 1895, outstanding liabilities	230.04
July 1, 1895, balance available	31,007.93

.This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ending June 30, 1895, amounted to $1,197,346.70.

The amount of internal revenue collected was $7,388,503.13.

W 4.

IMPROVEMENT OF KASKASKIA RIVER, ILLINOIS.

A survey of this stream from New Athens to its mouth was made in 1887.

The project for improvement, adopted in 1890, consists in deepening the water over the two principal shoals between the mouth of the river and Evansville, viz, at the Nine Mile and the Evansville shoals, and in removing snags and other obstructions from the mouth of the Baldwin Bridge, a distance of about 22 miles. Estimated cost of the project, $10,500.

Before work for the improvement was undertaken by the Government the stream was practically blocked near its mouth during the low-water season by the Nine Mile Shoal, over which there was often a depth of only 9 inches when the St. Louis gauge read 6.5 feet. In addition, the navigation was greatly obstructed on account of snags, shoals, and bars.

At high water navigation was possible as far up the stream as New Athens.

The first appropriation for the improvement was $6,000, made by the river and harbor act of September 19, 1890.

During the fall and part of December, 1891, Nine Mile and Evansville shoals were excavated, the former so as to give a channel 75 feet wide and 36 inches deep, and the latter to give a channel 60 feet wide and 34 inches deep at low water, the excavated material being utilized in constructing dikes, etc., to concentrate the flow of water in the cuts. A number of snags were also removed from the channel.

This work was of great benefit to the commerce of the river.

The river and harbor act of July 13, 1892, appropriated $4,500 for the improvement. Under this appropriation work was resumed in September, 1892, by hired labor, and prosecuted until December 23, when it was suspended on account of cold weather. The work of the season (1892) consisted in removal of snags, trees, rack heaps, logs, and several rocks from the stream between Baldwin Bridge and Cox's Ferry, thus further improving the navigation.

The work of improvement during the fiscal year ended June 30, 1894, consisted in further removal of obstructions from the channel at Evansville Shoal and Nine Mile Shoal and from the river between the two shoals so far as the funds available would admit of, the length of river cleared of obstructions being about 8 miles. One hundred and seventy

cubic yards of rock and 51 snags were removed from the channel and 51 leaning trees from the banks during that year. The rock was utilized in repairing the dikes formerly built.

The work was done by hired labor. The rock was generally removed by drilling and blasting.

No work was done during the past fiscal year, the balance of funds, $39.20, being insufficient for carrying on work were it desirable to do so.

The result of all the work accomplished to date is that steamboats are enabled to navigate the stream at lower stages and for low-water seasons of greater length than formerly was the case.

Appropriations made by Congress for improving Kaskaskia River, Illinois.

By act of—	
September 19, 1890	$6,000
July 13, 1892	4,500
Total	10,500

The amount ($10,500) originally estimated as necessary for completion of the improvement having been appropriated, no further appropriation is here estimated for.

For amount of commerce benefited by the work, see table of commercial statistics herewith.

Money statement.

July 1, 1894, balance unexpended	$39.20
July 1, 1895, balance unexpended	39.20

COMMERCIAL STATISTICS, KASKASKIA RIVER, ILLINOIS.

[Compiled from information furnished by Mr. Nick Sauer, of Evansville, Ill., and Capt. Harvey Neville, of Chester, Ill.]

Articles.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Coal	400	300	100	200
Cord wood and lumber	2,054	3,000	5,475	4,877
Flour, grain, etc.	9,186	600	3,280	1,750
Merchandise	405	500	400	400
Total	12,045	4,400	9,255	7,227

List of steam-power boats engaged in commerce on the Kaskaskia River, Illinois.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Dolphin	135.8	22.8	4.8	156.16
Mary M. Michael	143.3	26.3	4.4	234.44
Nick Sauer	100	18	4	99.27
Four barges not named	150	28	5	500

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ending June 30, 1895, amounted to $1,197,346.70. The amount of internal revenue collected was $7,388,503.13.

APPENDIX X.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS, AND OF GALENA RIVER, ILLINOIS.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, LIEUT. COL. A. MACKENZIE AND LIEUT. CHARLES KELLER, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Operating snag boats and dredge boats on Upper Mississippi River.
2. Mississippi River between Missouri River and Minneapolis.
3. Operating and care of Des Moines Rapids Canal and Dry Dock.
4. Operating and care of Galena River improvement, Illinois.
5. Construction of Lock and Dam No. 2, Mississippi River between Minneapolis and St. Paul.

EXAMINATIONS AND SURVEYS.

6. Quincy Bay, Illinois.
7. La Crosse Harbor, Wisconsin.
8. East bank of Mississippi River from Warsaw to Quincy, Ill.
9. West bank of Mississippi River from Flint Creek to Iowa River.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 8, 1895.

GENERAL: I have the honor to transmit herewith the annual reports of Lieut. Col. A. Mackenzie, Corps of Engineers, and myself, upon the works in our charge during the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

CHARLES KELLER,
Second Lieut., Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

XI.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions, the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating navigation through bridges, inspection and repair of works, formation of temporary or permanent channels through obstructing bars, and in

general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi River.

The plant belonging to this work consists of the snag boats *General Barnard* and *J. G. Parke*, and to these are added, as occasion demands and circumstances permit, dredges, launches, barges, etc., belonging to the general appropriation. The operations of the snag boats and dredges extend from Minneapolis to the mouth of the Missouri River, about 724 miles. At times when the snag boats are not required on work above mentioned they are used under general or special appropriations for work of permanent construction.

By the river and harbor act of August 11, 1888, provision was made for operating snag boats and dredge boats on the Upper Mississippi River under a permanent appropriation, the annual expenditure being limited by the act to $25,000. There has been expended under the permanent appropriation during the fiscal year ending June 30, 1895, the sum of $25,000.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., from April 2 to October 29, 1894, and from May 15 to June 30, 1895. The snag boat *J. G. Parke* served as tender to dredge *Vulcan* in removing wrecks and deepening channels from July 19 to September 4, 1894. During remainder of that season and in June, 1895, she was employed on construction work between the Illinois and Missouri rivers, under the general appropriation for improvement.

The details of work accomplished, together with statistics of commerce and navigation, are given in the appended report of Assistant Engineer C. W. Durham.

A detailed statement and a summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1895, are appended.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of Missouri River for calendar year 1894 was, approximately, 2,975,000 tons. This includes logs and lumber as well as ordinary merchandise.

Abstract of appropriations.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
June 30, 1893	25,000
June 30, 1894	25,000
June 30, 1895	25,000
Total	699,640

Money statement.

June 30, 1895, amount drawn from Treasury under permanent appropriation	$25,000
June 30, 1895, amount expended during fiscal year	25,000
July 1, 1895, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1896	25,000

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1895.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	July, 1894.							
1	C. W. Durham	$4.00	$4.00					
2	S. C. and S. Carter	5.74						$5.74
3	Wilkinson & Co	90.40						90.40
4	Anchor Line store	81.20						81.20
5	Mississippi Coal and Ice Co	9.92			$9.92			
6	T. Nodler	11.20			11.20			
7	Klindt, Geiger & Co	16.30			16.30			
8	J. H. Scrogum	11.73			11.73			
9	Thos. E. Schindler & Co	26.10			26.10			
10	Frank J. Weess	13.50			13.50			
11	Chas. J. Long	19.15			13.70		$5.45	
12	Henry Dart's Sons	167.05			154.60		12.45	
13	Anchor Line store	15.30					15.30	
14	James Ward & Son	19.25			10.02		9.23	
15	L. T. Biethan	47.50				$47.50		
16	Quincy Coal Co	18.00				18.00		
17	M. McMahon	10.00				10.00		
18	Crown Coal and Tow Co	96.00				96.00		
19	F. W. Hansgen	14.00				14.00		
20	Henry A. Koettker	26.50			26.50			
21	Alois Boschert & Co	49.92			49.92			
22	Conrad Bros	8.96			8.96			
23	W. R. Tibbals	4.50					4.50	
24	C. W. Durham	250.00	250.00					
25	Hired men	649.34		$649.34				
	Total	1,665.56	254.00	649.34	352.45	185.50	46.93	177.34
	August, 1894.							
1	C. P. Comegys	3.50	3.50					
2	Hired men	674.85		674.85				
3	....do	1,405.33		1,405.33				
4	....do	70.67		70.67				
5	....do	69.83		69.83				
6	C. P. Disney & Son	100.00					100.00	
7	Empire Coal Co	133.30				133.30		
8	Gaunitz Bros. & Schwab	116.86			54.16	62.70		
9	James McNamara	174.24				174.24		
10	A. D. Thomas	109.31						109.31
11	J. J. Hogan	190.31				183.11	7.20	
12	C. W. Durham	5.75	5.75					
13	D. Joyce	5.51						5.51
14	L. T. Biethan	43.70				43.70		
15	Chas. Bernard	10.00				10.00		
16	F. W. Hansgen	30.50				30.50		
17	King & Frick	22.50				22.50		
18	T. C. Bright	33.00				33.00		
19	Diamond Jo Line steamers	50.00				50.00		
20	Coal Valley Mining Co	18.00				18.00		
21	Davis Co	28.55					28.55	
22	J. W. Stewart	11.13					11.13	
23	Penn Tank Line Co	38.00					38.00	
24	Wilkinson & Co	20.81					20.81	
25	Chas. A. Buncher	26.67			23.67		3.00	
26	Chas. J. Long	42.57			37.92		4.05	
27	Thomas E. Schindler & Co	60.37			60.37			
28	....do	25.65			25.65			
29	John Dillon	2.80			2.80			
30	J. H. Schneider & Co	59.69			58.34		1.35	
31	Maass & Sittler	28.91			28.91			
32	Klindt, Geiger & Co	13.35			13.35			

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	August, 1894—Continued.							
33	Narrley & Walsmith	$33.80			$33.80			
34	T. Nodler	86.38			81.98		$4.40	
35	H. G. Hodge & Sons	39.81			35.86		3.95	
36	The Pilot Steamboat Co	123.89				$123.89		
37	Empire Coal Co	41.50				41.50		
38	Adams Express Co	23.02						$23.02
39	F. J. Fugina	44.16				44.16		
40	Wm. A. Sutor	104.50				104.50		
41	Gaunitz Bros. & Schwab	6.10			5.00		1.10	
42	Grimm Bros	9.56			5.25		4.31	
43	Pie. E. Dunn	78.35			77.50		.80	
44	Joseph P. Franzina	4.40			4.40			
45	J. J. Metcalf	45.46			45.46			
46	J. W. Meiner	8.37			8.37			
47	E. Fritz	14.64			14.64			
48	Gentzkow Bros	81.15			81.15			
49	Hired men	1,475.00		$1,475.00				
50	.....do	737.50		737.50				
	Total	6,583.25	9.25	4,433.18	698.63	1,075.10	229.25	137.84
	September, 1894.							
1	Various persons	18.11			18.11			
2	C. W. Durham	16.35	16.35					
3	Charles Bernard	14.00				14.00		
4	Lizzie Haskin	15.00				15.00		
5	T. C. Bright	60.50				60.50		
6	W. H. Pape	7.50				7.50		
7	William A. Sutor	44.00				44.00		
8	John Espenship	25.00				25.00		
9	John Harry	59.00				59.00		
10	Northwestern Fuel Co	45.00				45.00		
11	John O'Neil	18.00				18.00		
12	King & Frick	22.50				22.50		
13	L. W. Abrams	10.00		10.00				
14	Hattie Brown	4.38				4.38		
15	C. F. Barrows	2.25			2.25			
16	J. Siegrist	8.75			8.75			
17	Uttley & White	10.48			9.98		.50	
18	Pie. E. Dunn	12.64			12.41		.23	
19	Klindt, Geiger & Co	19.60			19.60			
20	Pie. E. Dunn	19.30			19.30			
21	J. H. Scrogum	21.90			21.90			
22	Gaunitz Bros. & Schwab	55.34			33.34	22.00		
23	T. Nodler	15.20			15.20			
24	A. J. Stillwell Meat Co	10.50			10.50			
25	L. T. Biethan	36.00				36.00		
26	H. A. Koettker	8.15			8.15			
27	J. J. Hogan	73.11			66.61		.50	
28	Anchor Line store	136.74			87.54		36.22	12.98
29	A. Boschert & Co	29.92			29.92			
30	The W. A. Bonsack Lumber Co	24.08						24.08
31	Frank Brink	12.50				12.50		
32	Chas. J. Long	7.50			7.00		.50	
33	Thos. E. Schindler & Co	41.10			41.10			
34	J. W. Stewart	27.00					27.00	
35	Crown Coal and Tow Co	42.00				42.00		
36	H. G. Browning	36.00				36.00		
37	C. W. Durham	4.25	4.25					
38	Hired men	1,473.00		1,473.00				
39	.....do	85.50		85.50				
40	.....do	59.17		59.17				
	Total	2,631.32	20.60	1,627.67	411.66	463.38	70.95	37.06
	October, 1894.							
1	James Ward & Son	83.80			15.98		67.82	
2	St. Louis Tent and Awning Co	15.00					15.00	
3	Standard Oil Co	6.66					6.66	
4	L. T. Biethan	54.00				54.00		
5	H. J. Brown	17.25			1.00	16.25		
6	Gaunitz Bros. & Schwab	101.04			32.04	66.00	3.00	
7	T. C. Bright	8.80				8.80		

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	October, 1894—Continued.							
8	W. H. Pape	$12.50				$12.50		
9	Wm. A. Sutor	55.00				55.00		
10	Mississippi Coal and Ice Co	27.00				27.00		
11	John O'Neil	31.50				31.50		
12	H. O. Browning	36.00				36.00		
13	King & Frick	18.00				18.00		
14	The Consolidated Coal Co. of St. Louis	22.50				22.50		
15	George Lamont	12.60				12.60		
16	T. H. Thomas	14.70						$14.70
17	McIntire Reck D. G. Co	33.50					$33.50	
18	Chas. J. Long	39.11			$39.11			
19	Thos. E. Schindler & Co	50.31			50.31			
20	J. Siegrist	7.00			7.00			
21	Van Patten & Marks	19.43			19.43			
22	T. Nodler	3.90			3.90			
23	A. J. Stillwell Meat Co	12.60			12.60			
24	Conrad Bros	29.93			29.93			
25	Klindt, Geiger & Co	19.96			19.96			
26	John E. Cornell	4.00			4.00			
27	J. J. Hogan	13.57			13.57			
28	Furlong Grocery Co	24.05			24.05			
29	J. Kieffer	26.55			26.55			
30	T. C. Beckemir	3.50			3.50			
31	Albert Kirchner	9.46			9.46			
32	John Harry	50.83			50.83			
33	Gaunitz Bros. & Schwab	70.38			4.38	66.01		
34	Wm. A. Sutor	22.00				22.00		
35	F. W. Vanderwarker	42.50				42.50		
36	F. J. Fugina	23.00				23.00		
37	W. H. Pape	15.00				15.00		
38	The Consolidated Coal Co. of St. Louis	67.50				67.50		
39	H. O. Browning	45.00				45.00		
40	Geo. Lamont	36.00				36.00		
41	Chas. J. Long	24.85			24.85			
42	Thomas E. Schindler	38.25			38.25			
43	James Ward & Son	35.52			16.22		19.30	
44	J. H. Scrogum	1.00			1.00			
45	T. Nodler	1.35			1.35			
46	A. Boschert & Co	23.80			23.80			
47	Henry A. Kœttker	10.10			10.10			
48	Gentzkow Bros	24.50			24.50			
49	John Vanderbilt	4.50			4.50			
50	Anchor Line Store	36.66					4.95	31.71
51	The W. A. Bonsack Lumber Co	21.24						21.24
52	Standard Oil Co	38.32					38.32	
53	Hired men	1,453.67		$1,453.67				
54	.....do	162.33		162.33				
55	C. W. Durham	250.00	$250.00					
56	.....do	15.50	15.50					
	Total	3,327.02	265.50	1,616.00	512.17	677.15	188.55	67.65
	November, 1894.							
1	D. Tipton	5.00					5.00	
2	F. B. Martin	11.90	11.90					
3	I. Holmes	22.00				22.00		
4	James Phillips	20.00				20.00		
5	L. T. Biethan	27.00				27.00		
6	R. S. Owen	9.00				9.00		
7	L. T. Biethan	33.00				33.00		
8	Frank J. Weess	10.89			10.89			
9	St. Louis, Keokuk and Northwestern Rwy. Co	46.47					46.47	
10	Daniel Tripp	1.25					1.25	
11	T. Nodler	17.61			17.41		.20	
12	C. W. Durham	10.00	10.00					
13	Hired men	420.25		166.00				254.25
14	.....do	133.33		133.33				
	Total	767.70	21.90	299.33	28.30	111.00	52.92	254.25

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	December, 1894.							
1	C. W. Durham	$8.75	$8.75					
2	E. Schultz	6.75					$6.75	
3	S. C. & S. Carter	63.57						$63.57
4	D. Tipton	15.16	15.16					
5	Jones & Laughlins, Limited	20.26						20.26
6	Ewald Iron Co	11.09						11.09
7	Langstaff-Orm Manufacturing Co	445.37						445.37
8	Hired men	722.69		$165.00				557.69
	Total	1,293.64	23.91	165.00			6.75	1,097.98
	January, 1895.							
1	C. W. Durham	16.25	16.25					
2	Langstaff-Orm Manufacturing Co	173.70						173.70
3	Jones & Laughlins, Limited	4.30						4.30
4	S. C. & S. Carter	45.39						45.39
5	Hired men	861.99		165.00				696.99
	Total	1,101.63	16.25	165.00				920.38
	February, 1895.							
1	A. Weber Co	4.44						4.44
2	C. W. Durham	9.80	9.80					
3	A. Weber Co	4.11						4.11
4	S. C. & S. Carter	21.99						21.99
5	T. H. Thomas	2.00						2.00
6	D. Tipton	125.00		125.00				
7	Hired men	723.86		115.00				608.86
	Total	891.20	9.80	240.00				641.40
	March, 1895.							
1	C. W. Durham	15.25	15.25					
2	Anchor Line Store	36.24						36.24
3	S. C. & S. Carter	43.50						43.50
4	A. Weber Co	4.20						4.20
5	Wilkinson & Co	6.70						6.70
6	Seither & Cherry Co	19.92						19.92
7	Hired men	1,019.79		240.00				779.79
	Total	1,145.60	15.25	240.00				890.35
	April, 1895.							
1	C. W. Durham	7.00	7.00					
2	.....do	9.25	9.25					
3	D. Tipton	9.05	9.05					
4	Hired men	291.00		291.00				
5	.....do	475.50		182.50				293.00
	Total	791.80	25.30	473.50				293.00
	May, 1895.							
1	C. W. Durham	11.50	11.50					
2	Hired men	9.46						9.46
3	C. W. Durham	12.50	12.50					
4	D. Tipton	9.94	9.94					
5	A. D. Thomas	384.76						384.76
6	H. E. Wallace	206.18						206.18
7	S. C. & S. Carter	12.21						12.21
8	J. W. Erman	44.25						44.25
9	C. W. Durham	6.75	6.75					
10	W. A. Bonsack	24.40						24.40
11	St. Louis, Keokuk and Northwestern Rwy. Co	40.00					40.00	
12	Consolidated Coal Co. of St. Louis	144.30				$144.30		
13	T. Noller	49.50			$49.40		.10	
14	Frank J. Weess	37.30			37.30			
15	Standard Oil Co	6.12					6.12	
16	Mississippi Coal and Ice Co	129.31						129.31
17	Wilkinson & Co	1.50					1.50	

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	May, 1895—Continued.							
18	Hired men	$906.32		$906.32				
19	do	357.00		295.00				$62.00
20	A. Mackenzie, Lt. Col. Eng'rs.	20.18	$20.18					
	Total	2,413.48	60.87	1,201.32	$86.70	$144.30	$47.72	872.57
	June, 1895.							
1	McCabe Bros	12.35					12.35	
2	do	5.99					5.99	
3	John Ramming	36.48						36.48
4	A. D. Thomas	25.23						25.23
5	Mississippi Coal and Ice Co	1.20					1.20	
6	Eagle Boat Store Co	59.18			43.09		16.09	
7	Anchor Line Store	331.19			145.41		185.78	
8	do	5 55						5.55
9	do	123.97			36.10		87.87	
10	McCabe Bros	49.87					49.87	
11	J. W. Niemer	11.29			11.29			
12	Klindt, Geiger & Co	16.62			16.62			
13	J. H. Scrogum	21.82			21.82			
14	Wm. A. Sutor	66.00				66.00		
15	A. C. Gaunitz	23.04			23.04			
16	Gentzkow Bros	46.80			23.60	22.00	1.20	
17	Chicago, Burlington and Northern Rwy. Co	16.00					16.00	
18	J. Kieffer	10.70			10.70			
19	Furlong Grocery Co	9.65			9.65			
20	T. H. Thomas	10.12					10.12	
21	C. W. Durham	4.25	4.25					
22	Hired men	1,407.50		1,407.50				
23	do	93.00		93.00				
	Total	2,387.80	4.25	1,550.50	341.32	88.00	386.47	67.26

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1895.

Months.	Office expenses, superintendence, and contingencies.	Care, repair, and operating snag boats and dredge boats.						Grand total.
		Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.	
1894.								
July	$254.00	$649.34	$352.45	$185.50	$46.93	$177.34	$1,411.56	$1,665.56
August	9.25	4,433.18	698.63	1,075.10	229.25	137.84	6,574.00	6,583.25
September	20.60	1,627.67	411.66	463.38	70.95	37.06	2,610.72	2,631.32
October	265.50	1,616.00	396.60	812.02	169.25	67.65	3,061.52	3,327.02
November	21.90	299.33	28.30	111.00	52.92	254.25	745.80	767.70
December	23.91	165.00			6.75	1,097.98	1,269.73	1,293.64
1895.								
January	16.25	165.00				920.38	1,085.38	1,101.63
February	9.80	240.00				641.40	881.40	891.20
March	15.25	240.00				890.35	1,130.35	1,145.60
April	25.30	473.50				293.00	766.50	791.80
May	60.87	1,201.32	86.70	144.30	47.72	872.57	2,352.61	2,413.48
June	4.25	1,500.50	341.32	88.00	386.47	67.26	2,383.55	2,387.80
Total fiscal year.	726.88	12,610.84	2,431.23	2,744.43	1,029.54	5,457.08	24,273.12	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1895.

LIEUTENANT: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1895, together with some statistics of commerce and navigation:

Operations of snag boat General Barnard.—On July 2, 1894, the *Barnard* left Chimney Rock, going down river, and reached St. Louis on the evening of the 12th. On this trip snags and other obstructions were removed at or near Glenhaven, Cassville Slough, Pomme de Terre Prairie, Hershey Boom, Muscatine Island, Pond Lily, Fort Madison, Marion City, Hickory Chute, Martins Landing, Hatchet Chute, and Wood River. On July 16 the *Barnard* left St. Louis, going up river, and reached Keokuk July 21. Between St. Louis and Keokuk obstructions were removed at or near Ellis Island, Enterprise Island, Milan Point, Peruque Island, Reds Landing, Clarksville Chute, Hickory Chute, Ortons Island, and Nigger Island. At Keokuk July 21 the *Barnard* took hydraulic dredge *Geyser*, with her outfit of pontons and barges, and towed them to Trempealeau, 390 miles, arriving there August 3. After considerable delay, owing to low water and bad condition of channels, the *Barnard* reached St. Paul August 22. Between Keokuk and St. Paul snags and other obstructions were removed at or near Skunk River, Oquawka, Keithsburg, Dark Slough, Apple River Island, Bellevue Slough, Maquoketa Slough, Cassville Slough, Sand Slough, Mount Trempealeau, Broken Arrow Island, De Soto, Coon Slough, Blacksmith Chute, Wilds Landing, Chimney Rock, Davis Bend, West Newton Island, and Sturgeon Bay, and assistance was rendered in removing the wreck of the *Lady Franklin*.

Leaving St. Paul on August 23, the *Barnard* proceeded down river and reached St. Louis on September 12. On this trip some repairs were made to Stockholm Pier, and obstructions were removed in vicinity of Stock Yards, St. Croix River, Morgans Bar, Diamond Bluff, Beef River, Pap Chute, Dresbach Island, Coon Slough, Bad Axe Bend, Victory, Lost Channel, Battle Slough, Lynxville, Wyalusing, Hurricane Island, Bellevue Slough, Savanna, Hershey Chute, Muscatine, Port Louisa, Prairie Bird Bend, Fox Landing, Benton Island, Oquawka, Henderson River, Otter Island, Burlington, Devils Island, Bludsoes, Ortons Island, and Hickory Chute. On September 5 the *Silver Crescent* was met in a sinking condition near Port Louisa and saved from loss by use of the *Barnard's* pumps and crew. On September 14 the *Barnard* left St. Louis for up river; reached St. Paul October 7; started down river October 9, and returned to St. Louis October 19. On this trip obstructions were removed at or near Maple Island, Ellis Island, Piasa Island, Grafton, Enterprise Island, Iowa Island, McCanns Landing, Stag Island, Sterling Island, Reds Landing, Thomas Chute, Amaranth Island, Whitneys Bar, Hog Back, Curtis Island, Sauerweins Bend, Drews Prairie, Oquawka, Johnsons Island, Keithsburg, Credit Island, Sand Prairie, Glenhaven, Lansing, Illinois Chute, Skunk River, and Buzzard Island. On September 22 the remains of the wreck of the burned steamer *S. S. Merrill*, at Warsaw Landing, were broken up. On October 17 the boom connecting the lower lock of the canal with the Keokuk Bridge was detached from its moorings and placed in the canal. The *Barnard* left St. Louis October 22, and was laid up in the canal October 29. On the trip from St. Louis to Keokuk snags, etc., were removed at or near Maple Island, Hatchet Chute, Cap au Gris, Denmark Island, Hannibal, Marion City, Fabius Island, and Buzzard Island; the remains of a barge wreck at Hamburg were removed, as also some anchor mats near foot of Hickory Chute. On October 28 a trip was made to Montrose and several dangerous snags were removed from the channel near that place.

Repairs to the *Barnard* were carried on to close of the year.

During the season of 1894 the *Barnard* was in commission 214 days, and more work was accomplished than in any season since the snag-boat service was inaugurated, excepting in 1872, 1879, and 1881 in the former of which years two boats were employed and in the latter a great part of the work performed was in Cuivre River.

In 1895, the *Barnard*, having received considerable repairs during the winter, came out of the Des Moines Rapids Canal on May 15, and on the next day proceeded to St. Louis, arriving there on the 18th. On May 24, having been inspected, she proceeded up river, reaching Keokuk, June 1. On this trip snags and other obstructions were removed at or near Warsaw, Turtle Island, Hole in the Wall, Slim Island, Angle Island, Thomas Chute, Stag Island, Hat Island, Westport Island, Martins Landing, Peruque Island, Dardenne Island, Iowa Island, Point Landing, Perry Island, Enterprise Island, Masons Island, Grand View, Ellis Island, and Maple Island. May 29 to 31, the *Barnard* made an inspection trip from Clarksville to St. Louis and return. On June 2, left Keokuk for above, reached St. Paul on the 22d, and remained in vicinity to close of month. June 8 to 11, made inspection trip from Rock Island to Oquawka and return. On the trip from Keokuk to St. Paul, obstructions were removed at or

near Burlington, Otter Island, Dasher Slough, Oquawka, Keithsburg, New Boston, Port Louisa, Drurys Landing, Lyons, Fulton, Kellers, Arnolds, Sand Prairie, Goldens, Bellevue Slough, Galena River, Nine Mile Island, Maquoketa Slough, Parsons Bar, Turkey River, Cassville Slough, Wyalusing, Prairie du Chien, Lynxville, Crooked Slough, Lansing, Victory, Coon Slough, Betsy Slough, Rollingstone, Wacouta, Redwing, Trenton, St. Croix River, and Red Rock. A large bowlder in channel near Linwood was broken up with dynamite, and a barge wreck at Bellevue was destroyed.

Summary of operations of snag boat General Barnard for fiscal year ending June 30, 1895.

Snags removed	484
Leaning trees pulled back	21
Leaning trees felled	4,882
Wrecks removed	5
Rocks removed	3
Steamboats assisted	6
Ringbolts put in	1
Miles run	5,262

Operations of snag boat J. G. Parke and dredge Vulcan.—The *Parke*, on July 19, 1894, left Keokuk for Grafton, and there taking dredge *Vulcan* in tow proceeded up river. On July 31, began deepening channel at the bar above Fulton, and continued dredging at this locality until the night of August 6. The work resulted in a cut about 30 feet wide, 3½ feet deep, and 1,250 feet long, through the bar. This cut afterwards became choked with sand, rendering it unnavigable. August 7, the *Parke* and *Vulcan* moved on up river. August 8, removed a small pile of rock from the channel near Specht's Ferry. August 10 to 15, dredge *Vulcan* removed the wreck of the *Lady Franklin* at foot of Coon Slough, and a barge wreck at head of same slough. In breaking up the wreck of the *Lady Franklin*, considerable dynamite was used. August 11 the *Parke* raised the *Reindeer*, which had sunk on the wreck of the *Lady Franklin*. From August 16, to September 4 the *Parke* and *Vulcan* were employed under the general appropriation in deepening and widening channels above Trempealeau, below Winona and at Chimney Rock. From September 5 to end of season the *Parke* was employed on construction work between the Illinois and Missouri rivers, and the *Vulcan*, with a hired tender, continued dredging at Chimney Rock.

The cost of the work of the *Parke* and *Vulcan* charged to snag and dredge boats was $2,677.35.

In 1895 the *Parke* has been employed on construction work between Illinois and Missouri rivers.

Operations of towboat Vixen and dredge Phœnix.—Dredge *Phœnix*, with the *Vixen* as tender, was used for a time in removing obstructions. In July, 1894, a barge wreck near shore at Canton, and the wreck of the *W. H. Denny*, below Quincy, were removed. In the same month a temporary channel was cut through Wyaconda Bar, above La Grange. In August a temporary channel was made through the bar below Saverton, and snags to the number of 29 were removed at various points between Amaranth Island and Warsaw.

The cost of the above work charged to snag and dredge boats was $738.20.

RIVER NOTES.

In 1894, the river was at a good boating stage until the middle of June, when it commenced to fall. It reached an extremely low stage—lower at many points than ever before known—early in August, and remained low for the rest of the season. The long duration of very low water and the scant depth at many bars caused an almost entire cessation of navigation, the packets especially being unable to run at a profit. A great many of the raft boats were put out of commission, and the volume of river business was much smaller than usual.

At St. Paul, August 6, the river fell to 0.3 foot *below the zero* of the U. S. Engineer gauge. On the 10th it had risen to 0, and on the 11th the water from the reservoirs, which had been opened August 1, commenced to have effect, raising the river gradually to 1.3, August 14. This was the maximum gain, and was in great part maintained during the rest of the year. At Hastings, 27 miles below St. Paul, where the river also fell to —0.3, the reservoir water caused a rise in the river of about 1 foot, and this accretion was also maintained during the remainder of the season. At Redwing, 52 miles below St. Paul, where the gauge also showed a stage of —0.3, the effect of the reservoirs was to raise the water about 0.5, but even this small gain was but partially held.

At Reeds Landing, 84 miles below St. Paul, where the gauge also read —0.3, on August 11 and 24, the reservoir water had no apparent effect, nor at any other point farther down.

It is evident that the reservoirs aided navigation materially from St. Paul to Hastings, moderately from Hastings to Redwing, and not at all below Redwing; and it may be that the gathering and holding of water at the sources of the river caused in great part the lack of water which the reservoirs are designed to remedy; but, however that may be, it seems to me that the reservoirs should be opened before the river gets too low for navigation, as it did in 1894 before relief was given.

Between St. Paul and Hastings the least channel water found by the *General Barnard* was 3½ feet at Island No. 15. There were 4 feet at several other points, when the gauge at Hastings read 1.0. Between Hastings and Lake Pepin there were two bad crossings—above Diamond Bluff and at Sturgeon Bay; at both of which localities improvements were carried out during the season. At Winona the lowest point reached on the gauge was 0.4, and at La Crosse 0.8; from which it appears that the river was kept up to some extent at these points by local causes, such as the dams built in the vicinity during the seasons just preceding, local rains, movable dams in the Chippewa River, etc. Between Lake Pepin and Winona bad obstructions were found below Alma, below Minneiska, and at Lower Chimney Rock. Improvements were carried out at the last mentioned place, and also below Alma. Between Winona and La Crosse there were bad bars above Minneowa, at head of Blacksmith Slough, at Mount Trempealeau, at La Moille, below Trempealeau, at foot of Richmond Chute, at Queens Bluff, below Queens Bluff, at head of Dresbach Island, at head of Island 98, and at River Junction. Several of these bars were improved during the season. At North McGregor the river fell to 0.3; Dubuque, 0.4; Sabula, 0.2; Clinton, 0.1., and at Rock Island, 0.1. All of these gauges showed zero in 1891, except that at Dubuque, where a series of dams below the gauge has operated to hold the water up in some degree. Between La Crosse and North McGregor, shallow channels were found at Grand Crossing, above Picayune Island, Sand Slough, opposite Brownsville, at head of Coon Slough, and at Heytmans (stage, 0.8). In 1891, at a stage of 0.3, the *General Barnard* found only two crossings between Brownsville and La Crosse with less than 4.0, viz, above Brownsville and at Grand Crossing. Between North McGregor and Rock Island there were shallow crossings below Finleys, at Deadmans Bar, below Gordons Ferry, at Smiths Ferry, at Bellevue Slough, below Bellevue, below Sand Prairie, above Fulton, and at Comanche. The bar above Fulton was the worst in this stretch of river, and was improved during the latter part of the season. Between Rock Island and Keokuk the gauges recorded as follows: At Keithsburg, minus 0.3; at Burlington, minus 0.2; at Guard Lock, plus 0.3; at Lower Lock, minus 0.9. At each of these gauges the stage was the lowest ever known. At the Guard Lock the water was held up by a boom, and at the Lower Lock a boom was the cause of the water reaching so low a point. Between Rock Island and the Des Moines Rapids there were shallow places below Horse Island, opposite Dodges, opposite Buffalo, below Montpelier, below Fairport, head of Hershey Chute, above Muscatine Bridge, and in vicinity of Illinois Chute, Turkey Island, Benton Island, Drews Prairie, Pond Lily, and Pontoosuc. The bar in vicinity of Illinois Chute was at one time during the season the worst in the river between mouth of Missouri River and St. Paul.

The gauge at Keokuk Bridge (probably more correct than that at Lower Lock) indicated 0.2, and at Quincy Bridge the gauge indicated 0.3. The water at the latter point was undoubtedly held up by dams constructed below the bridge in 1893 and 1894, the gauge having recorded minus 0.3 in 1891. At Hannibal Bridge the water fell to minus 0.2, nearly the same as in 1891, which was 0.2 lower than in 1864. At Grafton the river fell to 0.8, and at Alton to 0.4, above the low water of 1891.

Between Keokuk and Quincy the river was especially bad at Wyaconda Creek, and was also shoal at mouth of Des Moines River, at Bludsoes, and at Curtis. Between Quincy and Clarksville obstructions were found at Whitneys and Saverton. Between Clarksville and Missouri River there were many points of difficulty, the worst of which were Tisdales, Reds Towhead, Turners Island, McCanns, Fruitland, Enterprise Island, Grafton, Piasa Island, and Hop Hollow.

During the spring months of 1885 the river remained at an unusually low stage, but the channel was well defined and in better condition than is usual at such low water. In June the water reached a medium stage.

Available channel depths, in feet, at the worst bars at low stages in 1894, as found by the snag boat General Barnard.

Between St. Paul and Prescott (30 miles).—Foot of Pigs Eye Island, 4; Kaposia, 4; below Stock Yards, 4; Island No. 15, 3½; Nininger Slough, 4; above Hastings, 4; head of Prescott Island, 4.

Between Prescott and Lake Pepin (29 miles).—Prescott, 4; foot of Prescott Island, 4; Morgans, 4; first crossing above Diamond Bluff, 3½; Sturgeon Bay, 3½; head of Lake Pepin, 3½.

Between Wabasha and Winona (38 miles).—Crats Island, 4; Tee-pee-ota Point, 3; Beef Slough Boom, 3½; below Beef River, 4; below Alma, 3½; Rollingstone, 4; Van Gorders, 4.

Between Winona and La Crosse (31 miles).—Above Minneowa, 3½; head of Blacksmith Slough, 3½; Mount Trempealeau, 3; La Moille, 3½; below Trempealeau, 3½; foot of Richmond Chute, 3½; Queens Bluff, 3½; below Queens Bluff, 3½; Hammond Chute, 4; above Dakota, 4; head of Dresbach Island, 3½; head of Island 98, 3½; River Junction, 3½.

Between La Crosse and Prairie du Chien (72 miles).—Grand Crossing, 3½; above Picayune Island, 3½; Sand Slough, 3½; Crosby Slough, 4; opposite Brownsville, 3½; head of Coon Slough, 3½; Heytmans, 3½.

Between Prairie du Chien and Le Claire (153 miles).—Finleys Landing, 3½; below Spechts Ferry, 4; Maquoketa Slough, 4; Nine Mile Island, 4; Deadmans, 3½; below Gordons Ferry, 3½; Smiths Ferry, 3½; Bellevue Slough, 3½; below Bellevue, 3½; below Sand Prairie, 3½; Arnolds, 3; above Savanna, 4; above Fulton, 2½; above Comanche, 3½; at Comanche, 3½.

Between Rock Island and Keokuk (130 miles).—Below Horse Island, 3½; opposite Dodges, 3½; opposite Buffalo, 3½; below Buffalo, 4; below Montpelier, 3½; below Fairport, 3½; head of Hershey Boom, 3½; above Muscatine Bridge, 3½; foot of Illinois Chute, 2½; Turkey Island, 3½; Edwards River, 4; Benton Island, 3½; Drews Prairie, 3½; Pond Lily, 3½; Pontoosuc, 3½; below Pontoosuc, 4; Appanooce, 4.

Between Keokuk and Quincy (41 miles).—Mouth Des Moines River, 3½; Upper Bludsoe, 3½; Lower Bludsoe, 3½; Curtis, 3½; Wyaconda, 3.

Between Quincy and Clarksville (58 miles).—South River, 4; Upper Whitneys, 3½; Lower Whitneys, 3½; Turtle Island, 4; Cave Hollow, 3½; below Saverton, 3½; foot of Hickory Chute, 4.

Between Clarksville and Missouri River (85 miles).—Eagle Island, 4; Amaranth, 4; Tisdales, 3½; below Tisdales, 3½; head of Thomas Chute, 4; Reds Towhead, 3½; foot of Turners Island, 3½; below McCanns, 3½; above Fruitland, 3½; Enterprise Island, 3½; Masons Island, 3½; opposite Grafton, 3½; Portage Island, 4; Piasa Island, 3½; Hop Hollow, 3½.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1894 to about 75 towboats, valued at $600,000. Along the river from Minneapolis to St. Louis 100 sawmills were operated by 84 wholesale lumber firms, having an invested capital of about $50,000,000. Their manufactures in 1894 were: Lumber, 1,164,828,793 feet, B. M.; shingles, 325,521,750; laths, 252,526,125. This shows a decrease in manufacture, as compared with 1893, of: Lumber, 55,747,950 feet, B. M.; shingles, 98,283,500; laths, 38,058,375. This decrease was due, in great part, to the extremely low water which prevailed during a great part of the season and which prevented the rapid transportation of logs.

In addition to the manufacturers there are a large number of retail or distributing firms.

Lumber manufacture, Upper Mississippi River Valley, 1894.

[Value about $21,000,000.]

Locality.	Lumber.	Shingles.
	Feet, B. M.	*Number.*
Minneapolis	491, 256, 793	121, 323, 750
St. Paul to St. Louis	673, 572, 000	204, 198, 000
St. Croix River	170, 440, 000	62, 567, 000
Black River	157, 595, 000	71, 040, 000
Chippewa River	281, 388, 000	144, 183, 000
Total	1, 774, 251, 793	603, 311, 750

The larger part of the above was floated for greater or less distance on the Mississippi River, either as logs or lumber. The total product (excluding shingles and laths), if shipped by rail, would have loaded 150,000 cars of 12,000 feet each (about 20 tons), the quantity generally accepted by lumbermen as a carload. Supposing an average length of car of 35 feet, it would have loaded a train 1,000 miles in length, or 7,500 trains of 20 cars each.

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1894.

Locality.	Lumber.	Shingles.	Laths
	Feet, B. M.	*Number.*	*Number.*
Minneapolis	491, 256, 793	121, 323, 750	93, 949, 125
Hastings	2, 750, 000	2, 000, 000	1, 000, 000
Redwing	8, 059, 000	3, 147, 000	1, 300, 000
Alma	900, 000	1, 000, 000	150, 000
Winona	119, 500, 000	53, 000, 000	38, 550, 000
Lansing	15, 000, 000	9, 000, 000	3, 000, 000
Prairie du Chien	12, 500, 000	10, 000, 000	2, 500, 000
Guttenberg	14, 000, 000	4, 700, 000	2, 114, 000
Cassville	1, 000, 000	900, 000	240, 000
Dubuque	51, 650, 000	17, 550, 000	7, 280, 000
Bellevue	2, 037, 000	.....	1, 076, 000
Lyons	12, 006, 000	1, 440, 000	1, 330, 000
Clinton	101, 662, 000	11, 239, 000	13, 500, 000
Fulton	14, 120, 000	4, 550, 000	2, 811, 000
Moline	28, 188, 000	3, 457, 000	4, 236, 000
Davenport	50, 500, 000	7, 300, 000	9, 100, 000
Rock Island	84, 500, 000	17, 174, 000	21, 970, 000
Muscatine	56, 000, 000	11, 000, 000	17, 000, 000
Burlington	27, 000, 000	5, 000, 000	14, 000, 000
Fort Madison	16, 000, 000	12, 720, 000	4, 800, 000
Keokuk	10, 000, 000	5, 000, 000	2, 000, 000
Canton	4, 700, 000	4, 521, 000	2, 029, 000
Quincy	21, 500, 000	10, 000, 000	3, 600, 000
Hannibal	20, 000, 000	9, 500, 000	5, 000, 000
Total	1, 164, 828, 793	325, 521, 750	252, 526, 125

Lumber manufacture on the Mississippi River from St. Paul to St. Louis for nine years.

Year.	Lumber.	Shingles.	Laths.
	Feet, B. M.	*Number.*	*Number.*
1894	673, 572, 000	204, 198, 000	158, 586, 000
1893	811, 576, 588	285, 897, 000	190, 394, 800
1892	931, 806, 305	357, 014, 775	228, 042, 910
1891	814, 228, 707	332, 666, 750	207, 722, 350
1890	1, 231, 678, 960	508, 966, 705	.....
1889	1, 044, 555, 298	463, 132, 700	.....
1888	1, 048, 951, 386	423, 655, 050	.....
1887	988, 361, 094	363, 239, 750	.....
1886	934, 735, 854	274, 581, 750	267, 888, 340
Total	8, 479, 466, 192	3, 213, 372, 480	.....

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, and the Joy Lumber Line. There are also many independent boats carrying freight and passengers. During the season of 1894 the amount of freight and number of passengers carried on boats and barges could not be accurately ascertained, but partial reports give 128,452 tons of freight and 186,700 passengers, not including those of ferry and excursion boats.

Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1894 was approximately 2,975,000 tons.

Statement of approximate tonnage of the Upper Mississippi River for nine years.

Year.	Tons.	Year.	Tons.
1886	3, 200, 000	1891*	3, 300, 000
1887	3, 500, 000	1892	3, 750, 000
1888	3, 750, 000	1893†	3, 200, 000
1889	3, 500, 000	1894*	2, 975, 000
1890	4, 200, 000		

* Very low water.

† Great business depression.

Statement of amount of freight received at and shipped from St. Louis by the Upper Mississippi, including logs and lumber, for four years.

St. Louis.	1894.	1893.	1892.	1891.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Received	239,735	238,220	265,655	232,955
Shipped	52,190	54,230	51,595	18,630
Total	291,925	292,450	317,250	251,585

Arrivals at and departures from St. Louis during 1894.

Steamboats and barges from Upper Mississippi River arrived at St. Louis 710
Steamboats and barges departed from St. Louis for Upper Mississippi River.... 714

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

List of steamboats, barges, and rafts passing through various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1894.	1893.	1892.	1894.	1893.	1892.	1894.	1893.	1892.
Hastings	709	487	601	900	327	579	116	90	86
Winona	3,715	4,428	5,268	1,422	1,324	957	1,172	1,655	1,759
La Crosse	2,017	3,956	4,984	883	2,091	1,047	908	1,407	1,901
Dubuque	2,132	2,744	3,385	1,128	1,253	1,458	428	627	736
Sabula	3,783	2,784	3,247	1,276	1,233	1 240	(*)	(*)	(*)
Clinton	2,052	2,491	3,253	667	659	719	† 292	† 411	† 423
Rock Island	2,110	2,183	1,847	613	485	1,805	509	576	756
Keithsburg	1,059	1,108	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Burlington	1,462	1,377	1,759	572	426	533	187	380	494
Fort Madison	1,272	1,252	(*)	436	(*)	(*)	167	(*)	(*)
Keokuk	1,233	1,678	2,687	901	1,586	2,640	121	153	201
Quincy	1,757	1,478	2,050	640	624	784	131	178	291
Hannibal	1,792	1,798	1,775	1,193	1.117	650	177	309	396
Louisiana	704	1,313	968	488	797	530	46	53	103

* No record. † Partial record.

The following table shows the navigation during a period of seventeen years through Winona Bridge, at which point the traffic is the largest:

Statement of steamers, barges, and rafts passing Winona Bridge during seventeen years.

Year.	Steamboats.	Barges.	Rafts.	Year.	Steamboats.	Barges.	Rafts.
1878	2,948	1,115	863	1887	4,300	1,600	1,100
1879	3,760	1,362	1,889	1888	4,740	684	1.894
1880	4,593	883	1,392	1889	4,419	1,140	1,387
1881	4,739	575	1,717	1890	5,417	1,045	2,123
1882	5,627	942	1,939	1891	3,687	1,108	1.495
1883	4,893	828	1,352	1892	5,268	957	1,759
1884	4,992	905	2,007	1893	4,428	1,324	1,655
1885	5,126	848	1,973	1894	3,715	1,422	1,172
1886	4,570	974	1,860				

Internal revenue for the year ending December 31, 1894, collected in districts bordering on the Upper Mississippi River.

Locality.	Office.	Amount.
Minnesota	St. Paul	$2,129,719.87
Second Wisconsin	Madison	501,377.13
Third Iowa	Dubuque	173,249.45
Fourth Iowa	Burlington	316,315.85
Fifth Illinois	Peoria	13,486,756.77
Eighth Illinois	Springfield	8,228,986.94
Thirteenth Illinois	Cairo	535,322.73
First Missouri	St. Louis	7,568,218.17
Total		32,939,946.91

Customs revenue and tonnage for the year ending December 31, 1894.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Paul, Minn	$241,302.00	2,212.62	25
La Crosse, Wis	9.06	4,831.16	58
Dubuque, Iowa	6,929.32	4,930.70	27
Rock Island, Ill		6,060.61	61
Burlington, Iowa	1,176.00	675.21	7
St. Louis, Mo.*	983,608.51	119,910.11	200
Total	1,233,024.89	138,620.41	378

*Only a part of the St. Louis statement applicable to the Upper Mississippi.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Second Lieut. CHARLES KELLER,
Corps of Engineers.

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in construction of rock, brush, piles, and gravel, which close side chutes and properly contract the lower-water channel, and in the protection of caving banks by use of the same materials. Between Minneapolis and St. Paul, in addition to works of construction, bowlders are removed and channels dredged through gravel bars; at Rock Island Rapids guide piers, to aid in the navigation of the rapids at night, are built, and rock ledges above grade within the proposed channel limits are removed by drilling, blasting, and dredging. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

At the commencement of the fiscal year there was available the sum of $140,934.21, to which was added by sundry civil act of August 18, 1894, $866,666.67, and by sundry civil act of March 2, 1895, a further sum of $866,666.67.

Work was carried on vigorously in 1894 subsequent to August 18, and in 1895 an early commencement was made both on contract and hired labor work. Under approved projects work of dam construction, shore protection, and removal of rocks and bowlders has been carried on during the past year by hired labor, competitive purchase of materials, and use of Government plant between St. Paul and Lake Pepin, between Reeds Landing and Genoa, at Rock Island Rapids, between Keithsburg and Nashville, between Quincy and Clarksville, and between the Illinois and Missouri rivers; under formal contract, between Smiths Bar and Lake Pepin, between Genoa and Prairie du Chien, between Dubuque and Clinton, between Muscatine and New Boston, between Quincy and Hannibal, between Hamburg and Cap au Gris, and between Cap au Gris and the Illinois River.

Continuous surveys of the river were made from Hastings to Lake Pepin, 31 miles; from Lake Pepin to Island 55, 28 miles; from Winona to Lamoille, 7½ miles; from Crooked Slough to Clayton, 40 miles; from

Rock Island to Montrose, 118 miles; and from Iowa Island to Missouri River, 33 miles.

The plant belonging to this appropriation received extensive repairs, and many pieces were added during the year.

The details of above-mentioned work are given in the appended reports of assistants in local charge.

Harbor at Burlington, Iowa.—No work was found necessary during the year, and the balance ($3,094.38) remaining from the allotment in act of September 19, 1890, is still available.

Dredging Quincy Bay.—An allotment of $15,000 was made by river and harbor act of August 17, 1894, from funds appropriated by sundry civil act of August 18, 1894. A project was submitted October 26 and approved by the Secretary of War November 3, 1894, proposing to continue dredging under original project for the improvement of Quincy Bay, to increase the depth at low water, and to extend operations over portions of the bay as yet unimproved. Dredging, under formal contract, was carried on in 1895, and a channel about 2,000 feet long, 80 feet wide, and 6 feet deep at low water has been made along the bulkhead at Whipple Creek.

Warsaw to Quincy.—The sundry civil act of March 2, 1895, in making appropriation for improvement of Mississippi River from the mouth of the Missouri River to Minneapolis, provides—

> That eighty-five thousand five hundred dollars thereof, or as much as may be necessary, shall be expended under the direction of the Secretary of War, with a view to improving the navigation from the city of Warsaw to the city of Quincy, by preventing the water from overflowing the natural and artificial banks along the east bank of that part of said river, and deepening the channel, in accordance with the survey reported on December thirteenth, eighteen hundred and ninety-four, and the accompanying estimates. * * *

A project was submitted by Lieutenant-Colonel Mackenzie March 30, 1895, which was approved by the Secretary of War April 5, 1895. The project, quoting from the report, says:

> There will be needed to raise and strengthen the banks in the Hunt district 241,989 cubic yards of earthwork; in the Lima Lake district, 67,286 cubic yards, and in the Indian Grave district 293,368 cubic yards; total, 602,643 cubic yards.

In May, 1895, a party of engineers was put in the field and the work was staked out. A contract for execution of the entire work was let to Casgrain & McDonald, of Chicago, Ill., and operations commenced shortly before the close of the fiscal year. The money appropriated will be sufficient to complete the work in accordance with the project and no further allotment is asked for.

Flint Creek to Iowa River.—The sundry civil act of March 2, 1895, in making appropriation for improvement of Mississippi River from the mouth of the Missouri River to Minneapolis, provides—

> That * * * eighty-five thousand dollars thereof shall be expended to commence the work, under the direction of the Secretary of War, from the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river to the mouth of the Iowa River, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along that part of the river, and deepening the channel, in accordance with the survey reported on January third, eighteen hundred and ninety-five, and the accompanying estimate.

Lieutenant-Colonel Mackenzie, in his project dated April 11, 1895, approved by the Secretary of War April 18, 1895, quoting from his report, says:

> The questions of outlets and interior drainage have not been considered. An earthen bank is estimated for, with a slope of 3 to 1 on the river side and 2 to 1 on the inside, with 4 feet width of crown, to reenforce and raise the natural bank where

necessary, and following the transit lines as above described. The grade of the top of the bank is placed at 3 feet above high water of 1888, which will probably be of sufficient elevation to restrain any flood that is likely to occur. The average height of artificial bank will be about 8¼ feet and its length 42 miles.

The estimate calls for 1,855,193 cubic yards earthwork, at 15 cents per yard, and, adding 10 per cent for engineering and contingencies, amounts to $305,000.

Colonel Mackenzie's project further says:

With the money available ($85,000) it is proposed to construct a levee from Flint Creek to the Iowa River of the same slopes and width of crown as given above, its grade to be as high as funds will permit. It is thought best to build a complete levee, which will be of sufficient height to resist all but very high floods, and afterwards to enlarge it, as appropriations may be made. * * * I would propose to perform the work by formal contract. * * *

A party was put in the field on June 1, 1895, which has made a final location of the levee line, staked out the necessary right of way, and secured, without cost, deeds to the United States of the right of way for about 30 miles. The party is now engaged in setting slope stakes, and the contract will soon be advertised.

To complete the work in accordance with the original project the sum of $220,000 will be needed.

Harbor at Bay City, Wis.—The sundry civil act of March 2, 1895, in making appropriation for improvement of Mississippi River from the mouth of Missouri River to Minneapolis, provides:

That * * * not to exceed one thousand dollars, may, in the discretion of the Secretary of War, be expended in the improvement of the channel to the harbor of Bay City, Wisconsin, at the head of Lake Pepin. * * *

Lieutenant-Colonel Mackenzie, in his project of June 3, 1895, approved by the Secretary of War June 12, 1895, says:

To improve the channel by dredging was found to be impracticable without a very large expenditure of money. It was thought best, with the sum available, to construct an earthen embankment about 300 feet long, running directly out into the lake from the village front, and to protect this bank with riprap or paving. Boats can use this pier as a landing and also as a protection harbor or breakwater.

The estimate for a pier 300 feet long, 8 feet wide on top, and with crest elevation of 8 feet above low water, is $1,000.

The work, which is to be performed by hired labor and use of Government plant, has not been commenced.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "Operating snag boats and dredge boats on Upper Mississippi River." These statistics do not fully indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi River in an improved condition has upon freight rates must be taken as a measure of its importance. Of the amount of freight carried by railroads at river rates, as a result of the river competition, no figures can be given, but such amount is known to be very large during the season when navigation of the river is practicable.

During the past year the works heretofore constructed by the Government have continued to straighten and deepen the low-water channel of the river and to materially benefit the interests of commerce and navigation. That such benefit should continue and increase it is necessary that the work of improvement be continued until the whole river is put under such control that the possibility of new obstructions appearing is done away with.

If the radical improvement of the Upper Mississippi River is to be continued and carried to the full limits which the immense interests involved justify, it is desirable that it should be carried on under liberal

appropriations, so that the full benefit of the improvement may be secured at as early a day as is practicable. As an amount that can be profitably expended during the fiscal year ending June 30, 1897, I present an estimate of $1,000,000.

The improvement of the Upper Mississippi River is a work which can be best carried on so gradually as to give the river itself full opportunity to assist in the formation of proper channels, and if carried to its fullest limits the work must extend over many years. It does not now appear desirable or even practicable to prepare detailed plans for the whole river so long in advance of the time when it may be possible or necessary to carry out some of the work. The existing project for this work may therefore be said to be one of general methods and the execution of detailed plans for special localities. Under the conditions named no detailed estimates of cost of completing the entire work can well be now made. Projects for the expenditure of each appropriation, in accordance with approved plans and methods, are presented in lieu of a general project for the completion of work. It has been the custom in carrying out work on the Upper Mississippi to select, when funds are available, such localities for improvement as may be at the time most detrimental to navigation. Each and every locality thus improved has a beneficial result on the navigation of the whole river, and as the shoalest bars have been improved from year to year the ruling navigable depth has been considerably increased. By this method the good effects of work are spread over the entire stretch of river, and the improvement of the river, considered as a whole, is made progressive, the expenditure of each successive appropriation resulting in further and immediate benefit to the interests of continuous navigation.

Summary of expenditures for calendar year ending December 31, 1894, under appropriations for improving Mississippi River, "Ohio River to Minneapolis," applied to that portion of the river between the mouth of the Missouri River and Minneapolis; "Minneapolis to Des Moines Rapids" and "Des Moines Rapids to Illinois River."

Minneapolis to St. Paul (survey for Lock No. 2)	$2,113.36
St. Paul to Lake Pepin	39,251.24
Dredging, vicinity of Diamond Bluff	4,118.49
Smiths Bar to Lake Pepin	16,373.59
Stockholm Pier	27.39
Reeds Landing to Genoa	104,017.56
Dredging, vicinity of Chimney Rock	5,197.04
Genoa to Prairie du Chien, two contracts	16,215.97
Glenhaven to Dubuque	23.06
Dubuque to Clinton, two contracts	68,754.43
Rock excavation at Princeton	970.91
Rock Island Rapids	39,036.90
Buoys on Rock Island Rapids	347.08
Keithsburg to Nashville	15,811.10
Rock excavation, vicinity of Keithsburg to Nashville	5,413.32
Keokuk to Quincy	40,831.13
Repairs, Canton Chute Dam	5,470.83
Removing wrecks and deepening channel, Keithsburg to Clarksville	1,869.24
Quincy Bay	3,704.38
Quincy to Hannibal	36,024.18
Quincy to Clarksville	30,723.56
Hannibal Ferry Dike	2,107.45
Clarksville to Hamburg	28,948.72
Hamburg to Cap au Gris, two contracts	54,904.91
Hamburg to Cap au Gris, pile dams	6,598.60
Cap au Gris to Illinois River, two contracts	61,011.33
Illinois River to Missouri River	55,068.22
Purchase, construction, care, and repair of plant	75,514.44
Surveys and gauges	19,622.06
Total	740,070.49

NOTE.—In above statement retained percentages on contracts and other liabilities outstanding December 31, 1894, are included.

Summary showing localities, amounts and cost of regular construction works in 1894, between St. Paul and mouth of Missouri River.

Locality.	Method.	Material.		
		Rock.	Brush.	Total.
		Cubic yds.	*Cubic yds.*	*Cubic yds.*
St. Paul to Lake Pepin	Hired labor	26,642.9	40,319.5	66,962.4
Reeds to Genoa	do	42,122.7	184,214.8	226,337.5
Keithsburg to Nashville	do	13,371.4	9,134.6	22,506
Quincy to Clarksville	do	18,717.4	27,105.6	45,823
Illinois River to Missouri River	do	45,675.4	45,541.6	91,217
Smiths Bar to Lake Pepin	Formal contract	30,082.8	19,681.2	49,764
Genoa to Prairie du Chien (1)*	do	26,003.4	30,712.7	56,716.1
Genoa to Prairie du Chien (2)	do	3,804.4	3,952.5	7,756.9
Dubuque to Clinton (1)*	do	29,533.4	34,230.4	63,763.8
Dubuque to Clinton (2)	do	8,422.2	9,384.1	17,806.3
Keokuk to Quincy (1)*	do	52,828.5	39,989	92,817.5
Keokuk to Quincy (2)	do	10,485.2	8,191.5	18,676.7
Quincy to Hannibal	do	29,884.6	21,243.5	51,128.1
Clarksville to Hamburg	do	27,068.7	19,300.1	46,368.8
Hamburg to Cap au Gris (1)*	do	41,320.8	40,993	82,313.8
Hamburg to Cap au Gris (2)	do	12,344.6	8,731.9	21,076.5
Cap au Gris to Illinois River	do	35,531.5	30,807.1	66,338.6
Total		453,839.9	573,533.1	1,027,373

Locality.	Cost of work.	Average cost per cubic yard on barges.	Average cost per cubic yard for towing and putting in material.	Average cost per cubic yard for general superintendence, office expenses, and inspection.	Average cost per cubic yard for plant.	Average cost per cubic yard in place.
St. Paul to Lake Pepin	$42,478.45	$0.334	$0.243	$0.013	$0.044	$0.634
Reeds to Genoa	111,587.04	.276	.174	.010	.033	.493
Keithsburg to Nashville	17,507.80	.444	.229	.017	.087	.777
Quincy to Clarksville	34,830.84	.351	.304	.015	.090	.760
Illinois River to Missouri River	59,241.59	.328	.243	.014	.064	.649
Smiths Bar to Lake Pepin	46,143.97	.....	.....	.044	.....	.927
Genoa to Prairie du Chien (1)*	44,304.44	.....	.....	.040	.....	.781
Genoa to Prairie du Chien (2)	6,068.18	.....	.....	.093	.....	.782
Dubuque to Clinton (1)*	55,245.11	.....	.....	.037	.....	.866
Dubuque to Clinton (2)	13,668.18	.....	.....	.047	.....	.768
Keokuk to Quincy (1)*	96,025.72	.....	.....	.048	.....	1.085
Keokuk to Quincy (2)	15,968.98	.....	.....	.037	.....	.855
Quincy to Hannibal	44,149.28	.....	.....	.046	.....	.864
Clarksville to Hamburg	49,103.52	.....	.....	.064	.....	1.059
Hamburg to Cap au Gris (1)*	77,846.68	.....	.....	.067	.....	.946
Hamburg to Cap au Gris (2)	16,666.67	.....	.....	.046	.....	.791
Cap au Gris to Illinois River	61,006.64	.....	.....	.049	.....	.920
Total	791,838.09	.....	.....	.....	.....	.771

* Includes work of 1893, in which year the contracts were let.

Average cost per cubic yard in place, day-labor work, $0.586.
Average cost per cubic yard in place, contract work, $0.916.
Day-labor work: Average cost of towing and putting in material, 1891, $0.233; 1892, $0.295; 1893, $0.237; 1894, $0.214.

Abstract of appropriations.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000.00
March 3, 1879	100,000.00
June 14, 1880	150,000.00
March 3, 1881	200,000.00
By act passed August 2, 1882	250,000.00
By act approved—	
July 5, 1885 (general improvement)	250,000.00
July 5, 1884 (applied to harbor, Lake City)	15,000.00
August 5, 1886	382,500.00
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000.00
By act of September 19, 1890	500,000.00

Des Moines Rapids to Illinois River:	
By act approved—	
June 18, 1878	$100,000.00
March 3, 1879	40,000.00
June 14, 1880	100,000.00
March 3, 1881	175,000.00
By act passed August 2, 1882	200,000.00
By act approved—	
July 5, 1884	200,000.00
August 5, 1886	150,000.00
By act of August 11, 1888	200,000.00
By act of September 19, 1890	165,000.00
Ohio River to Minneapolis, applied to "between Missouri River and Minneapolis":	
By act approved—	
July 13, 1892	600,000.00
March 3, 1893 (sundry civil)	866,666.67
August 18, 1894 (sundry civil)	866,666.67
March 2, 1895 (sundry civil)	866,666.67
Total	7,227,500.01

General statement showing net expenditures from the commencement of improvement to July 1, 1895, under various appropriations.

St. Paul to Des Moines Rapids		$1,560,323.17
Practical test of Adams Flume (St. Paul to Des Moines Rapids)		*22,176.83
Harbor at Lake City (St. Paul to Des Moines Rapids)		15,000.00
Minneapolis to Des Moines Rapids		1,096,905.62
Des Moines Rapids to Illinois River		1,330,000.00
Ohio River to Minneapolis (applied to "between mouth of Missouri River and Minneapolis")		2,048,986.01
Total net expenditures		6,073,391.63
Balances July 1, 1895—		
Minneapolis to Des Moines Rapids	†$3,094.38	
Ohio River to Minneapolis	1,151,014.00	
		1,154,108.38
Total appropriated		7,227,500.01

Net expenditures on the various sections of the river between Minneapolis and the Missouri River from commencement of improvement to July, 1895.

Locality.	Distance.	Amount.
	Miles.	
Minneapolis to St. Paul (Omaha Bridge)	11	$61,618.40
St. Paul (Omaha Bridge) to Prescott	32	638,498.56
Prescott to Lake Pepin	29	189,897.50
Harbors in Lake Pepin	.....	16,119.50
Foot of Lake Pepin to Alma	12	341,439.26
Alma to Winona Bridge	29	486,219.00
Winona Bridge to La Crosse Bridge	31	236,139.39
La Crosse Bridge to McGregor Bridge	72	376,353.91
McGregor Bridge to Dubuque Bridge	59	137,338.27
Dubuque Bridge to Clinton Bridge	67	213,941.78
Clinton Bridge to Rock Island Bridge	40	292,979.93
Rock Island Bridge to Keithsburg Bridge	58	70,171.28
Keithsburg Bridge to Des Moines Rapids	60	567,553.45
Keokuk to Quincy	40	398,518.58
Quincy Bridge to Clarksville	60	645,389.58
Clarksville to Cap au Gris	43	453,643.04
Cap au Gris to Illinois River	27	200,072.20
Illinois River to Missouri River	25	139,398.98
Flint Creek to Iowa River Levee	.....	1,991.89
Warsaw to Quincy Levee	.....	2,614.80
Soy Levee	.....	56,728.99
Quincy Bay‡	.....	46,664.06
Hamburg Bay	.....	10,000.00
Surveys, gauges, and meter work	.....	183,901.10
Snag and dredge boats and wrecking	.....	59,661.11
Facilitating navigation through bridges	.....	2,072.72
Practical test of Adams's flume	.....	27,176.83
Plant at estimated value	.....	217,287.52
Total	.....	6,073,391.63

* In addition to this amount Mr. Adams expended $13,000, appropriated by acts of August 2, 1882, and July 13, 1892.

† Belongs to harbor at Burlington, Iowa.

‡ $25,000 additional expended at Quincy Bay under special appropriation.

Money statements.

MINNEAPOLIS TO DES MOINES RAPIDS.

July 1, 1895, balance unexpended and available belonging to harbor at Burlington, Iowa	$3,094.38

OHIO RIVER TO MINNEAPOLIS, APPLIED TO THAT PORTION OF THE RIVER BETWEEN THE MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

July 1, 1894, balance unexpended		$290,365.04
Amount appropriated by sundry civil act approved August 18, 1894		866,666.67
Amount appropriated by sundry civil act approved March 2, 1895		866,666.67
		2,023,698.38
June 30, 1895, amount expended during fiscal year		872,684.38
July 1, 1895, balance unexpended		1,151,014.00
July 1, 1895, outstanding liabilities	$63,868.02	
July 1, 1895, amount covered by uncompleted contracts	312,489.72	
		376,357.74
July 1, 1895, balance available		774,656.26
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		1,000,000.00

Comparative cost of materials, 1894.

Locality of delivery.	Rock, per cubic yard.			Brush, per cubic yard.		Piling.
	In place.	On United States barges.	On bank.	In place.	On United States barges.	Per linear foot on United States barges.
St. Paul to Lake Pepin		$0.44½			$0.25	
Do					.29½	
Smiths Bar to Lake Pepin	$1.20			$0.40		
Alma		.62				
Minneiska		.60				
Mount Vernon		.62				
Chimney Rock, vicinity of		.50			.22	
Chimney Rock and Homer, vicinity of					.19½	
Do					.1985	
Fountain City		.63½				
Do		.55				
Fountain City to Brownsville		*.53				
Winona, vicinity of		.55				
Minneowa		.50				
Homer, vicinity of		.50				
Dakota		*.42				
Do		*.45				
Genoa to Prairie du Chien	1.14		$0.40			
Do	1.00		.39			
Glenhaven to Dubuque	1.00		.39			
Dubuque to Clinton	1.24		.47			
Do	1.30		.20			
Rock Island Rapids, vicinity of		.55				
Do		.53				
Do		†1.80				
Do		†1.90				
Burlington, vicinity of		.54				
Do						$0.07
Do		.68				

Comparative cost of materials, 1894—Continued.

Locality of delivery	Rock, per cubic yard.			Brush, per cubic yard.		Piling.
	In place	On United States barges.	On bank.	In place.	On United States barges.	Per linear foot on United States barges.
Burlington and Benton, vicinity of					$0.25	
Dallas City, vicinity of		$0 54			.25	
Pontoosuc, vicinity of		.54				
Nauvoo		.63½				
Nauvoo, vicinity of		.54				
Keokuk, vicinity of		.54				
Keokuk to Quincy						$0.09
Do	$1.30			$0.20		
Do	1 37	.58		.47		
Canton, vicinity of					.20	
Quincy		.62				
Quincy Bridge to Hannibal	1 09			.43		
Quincy Bridge to Louisiana					.22	
Quincy Bridge to Clarksville					.30	
Hannibal, vicinity of					.22	
Hannibal		.54				
Hannibal to Saverton		.54				
Louisiana		.50				
Do		.49½				
Louisiana, vicinity of					.22	
Clarksville to Hamburg	1.35				.49	
Do	1.20				.10	
Hamburg to Cap au Gris	1.25			.50		
Do	1.20			.10		
Cap au Gris to Illinois River	1.24			.44		
Do	1.10			.10		
Grafton		.43				
Alton, vicinity of		.43				
Illinois River to Missouri River		.57			.23	
Portage des Sioux, vicinity of					.23	

* Soft sand rock. † Slope wall rock.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., September 22, 1894, at 2 p. m.

[There is available for the following works from appropriation of $1,500,000 made by the sundry civil act approved August 18, 1894, for "improving Mississippi River from mouth of Ohio River to Minneapolis," an allotment of $366,666.67 made by said act for "improving Mississippi River between mouth of Missouri and Minneapolis."]

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN GENOA AND PRAIRIE DU CHIEN, WIS.

[Allotment of $40,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	20,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis.*	$1.00	$20,000	39	$9,750	$29,750
2	Christie & Lowe, Chicago, Ill	1.45	29,000	60	15,000	44,000
3	Bigelow & Teasdale, La Crosse, Wis	1.24	24,800	42	10,500	35,300
4	Jacob Richtman, Fountain City, Wis	1.30	26,000	20	5,000	31,000
5	Andrew J. Whitney, Rock Island, Ill	1.19	23,800	50	12,500	36,300
6	William P. Truax, Hastings, Minn	1.20	24,000	40	10,000	34,000

* Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN GLENHAVEN, WIS., AND DUBUQUE, IOWA.

[Allotment of $40,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	20,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis.*	$1.00	$20,000	39	$9.750	$29,750
2	Christie & Lowe, Chicago, Ill	1.45	29,000	60	15,000	44,000
3	Bigelow & Teasdale, La Crosse, Wis	1.24	24,800	47	11,750	36,550
4	Jacob Richtman, Fountain City, Wis	1.30	26,000	20	5,000	31,000
5	Andrew J. Whitney, Rock Island, Ill	1.09½	21,900	50	12,500	34,400
6	William P. Truax, Hastings, Minn	1.19	23,800	39	9,750	35,550

*Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN DUBUQUE AND CLINTON, IOWA.

[Allotment of $40,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	20,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis	$1.15	$23,000	45	$11,250	$34,250
2	Christie & Lowe, Chicago, Ill	1.45	29,000	60	15,000	44,000
3	Kelly & Monroe, Portsmouth, Ohio	1.34	26,800	59	14,750	41,550
4	Bigelow & Teasdale, La Crosse, Wis	1.16	23,200	38	9,500	32,700
5	Jacob Richtman, Fountain City, Wis.*	1.30	26,000	20	5,000	31,000
6	Andrew J. Whitney, Rock Island, Ill	1.20	24,000	50	12,500	36,500
7	Sid. J. Truax, Hastings, Minn	1.19½	23,900	35	8,750	32,650
8	James Short, St. Charles, Mo	1.19	23,800	42	10,500	34,300

* Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN KEOKUK, IOWA, AND QUINCY, ILL.

[Allotment of $40,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	20,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis	$1.35	$27,000	59	$14,750	$41,750
2	Christie & Lowe, Chicago, Ill	1.28	25,600	50	12,500	38,100
3	H. S. Brown, Quincy, Ill	1.40	28,000	60	15,000	43,000
4	L. W. Lewis, Emporia, Kans	1.24	24,800	42	10,500	35,300
5	Jacob Richtman, Fountain City, Wis.*	1.30	26,000	20	5,000	31,000
6	Andrew J. Whitney, Rock Island, Ill	1.30	26,000	60	15,000	41,000
7	Sid. J. Truax, Hastings, Minn	1.23	24,600	50	12,500	37,100
8	Patterson Bros., Keokuk, Iowa	1.08	21,600	40	10,000	31,600
9	James Short, St. Charles, Mo	1.32	26,400	50	12,500	38,900
10	Kelly & Monroe, Portsmouth, Ohio	1.37½	27,500	49	12,250	39,750

* Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN CLARKSVILLE, MO., AND HAMBURG, ILL.

[Allotment of $50,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	20,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis.	$1.25	$25,000	45	$11,250	$36,250
2	Christie & Lowe, Chicago, Ill.	1.23	24,600	48	12,000	36,600
3	R. L. Van Sant, St. Louis, Mo.	1.35	27,000	49	12,250	39,250
4	Jacob Richtman, Fountain City, Wis.*	1.20	24,000	10	2,500	26,500
5	Andrew J. Whitney, Rock Island, Ill.	1.29	25,800	60	15,000	40,800
6	Patterson Bros., Keokuk, Iowa.	1.13	22,600	43	10,750	33,350
7	Sid. J. Truax, Hastings, Minn.	1.29½	25,900	40	10,000	35,900
8	James Short, St. Charles, Mo.	1.09	21,800	40	10,000	31,800
9	Kelly & Monroe, Portsmouth, Ohio.	1.40	28,000	49	12,250	40,250

* Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN HAMBURG, ILL., AND CAP AU GRIS, MO.

[Allotment of $50,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis.	$1.10	$27,500.00	45	$11,250	$38,750.00
2	Christie & Lowe, Chicago, Ill.	1.23	30,750.00	48	12,000	42,750.00
3	Jacob Richtman, Fountain City, Wis.*	1.20	30,000.00	10	2,500	32,500.00
4	Andrew J. Whitney, Rock Island, Ill.	1.30	32,500.00	60	15,000	47,500.00
5	Sid. J. Truax, Hastings, Minn.	1.08½	27,218.75	40	10,000	37,218.75
6	Patterson Bros., Keokuk, Iowa.	1.15	28,750.00	43	10,750	39,500.00
7	James Short, St. Charles, Mo.	1.06	26,500.00	35	8,750	35,250.00
8	R. L. Van Sant, St. Louis, Mo.	1.19	29,750.00	44	11,000	40,750.00

* Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN CAP AU GRIS, MO., AND MOUTH OF ILLINOIS RIVER.

[Allotment of $50,000 made by project approved August 21, 1894.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Albert Kirchner, Fountain City, Wis.	$0.97	$24,250	50	$12,500.00	$36,750.00
2	Christie & Lowe, Chicago, Ill.	1.23	30,750	48	12,000.00	42,750.00
3	H. S. Brown, Quincy, Ill.	1.25	31,250	60	15,000.00	46,250.00
4	Jacob Richtman, Fountain City, Wis.*	1.10	27,500	10	2,500.00	30,000.00
5	Andrew J. Whitney, Rock Island, Ill.	1.29	32,250	60	15,000.00	47,250.00
6	Sid. J. Truax, Hastings, Minn.	1.00	25,000	39½	9,968.75	34,968.75
7	Patterson Bros., Keokuk, Iowa.	1.15	28,750	50	12,500.00	41,250.00
8	James Short, St. Charles, Mo.	0.95	23,750	30	7,500.00	31,250.00
9	R. L. Van Sant, St. Louis, Mo.	1.19	29,750	43	10,750.00	40,500.00

* Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., December 28, 1894, at 2 p. m., for dredging in Quincy Bay, Illinois.

[Allotment of $15,000 made by project approved November 3, 1894, the same being a discretionary allotment made by river and harbor act of August 17, 1894.]

No.	Name and address of bidder.	Price per cubic yard dredged and removed.	Remarks.
		Cents.	
1	H. S. Brown, Quincy, Ill	13¼	Guarantee incomplete.
2	Charles H. Appleton, Stillwater, Minn	14½	Certified by a notary.
3	William A. Kirk, Madison, Iowa	14⅝	No certificate.
4	A. J. Whitney, Rock Island, Ill	8 1/10	Accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., April 15, 1895, at 2 p. m., for construction of dams and shore protections between Muscatine, Iowa, and New Boston, Ill.

[Allotment of $45,000 made by project approved March 9, 1895.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		30,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	A. B. Teasdale, Cassville, Wis	$1.18	$29,500	38	$11,400	$40,900
2	Albert Kirchner, Fountain City, Wis	1.17	29,250	37	11,100	40,350
3	Jacob Richtman, Fountain City, Wis	1.40	35,000	20	6,000	41,000
4	Sid. J. Truax, Hastings, Minn	1.34	33,500	60	18,000	51,500
5	Monroe & Kelly, Portsmouth, Ohio	1.45	36,250	70	21,000	57,250
6	A. J. Whitney, Rock Island, Ill	1.19	29,750	38	11,400	41,150
7	James Short, St. Charles, Mo	1.24	31,000	19	5,700	36,700
8	Patterson Bros., Keokuk, Iowa *	1.12	28,000	13	3,900	31,900

* Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., May 14, 1895, at 2 p. m.

ENLARGEMENT AND REPAIR OF LEVEES BETWEEN WARSAW AND QUINCY, ILL.

[Allotment of $85,500 also made by said act, the project under this allotment having been approved April 5, 1895.]

No.	Name and address of bidder.	Hunt and Lima Lake district: 300,000 cubic yards earthwork.		Indian Grave district: 300,000 cubic yards earthwork.	
		Per cubic yard.	Total.	Per cubic yard.	Total.
		Cents.		*Cents.*	
1	McManus & Joyce, Keokuk, Iowa	10.95	$32,850	13.75	$41,250
2	John Breheney & Sons, Keokuk, Iowa	13.00	39,000	14.00	42,000
3	T. S. Aderholdt, Friars Point, Miss	12.74	38,220	12.44	37,320
4	Casgrain & McDonald, Chicago, Ill.*	8.95	* 26,850	10.95	* 32,850
5	R. M. Quigley & Co., St. Louis, Mo	12.22	36,660	12.22	36,660
6	Martin Jennings, Memphis, Tenn	12.19	36,570	12.89	38,670
7	Kelly & Monroe, Portsmouth, Ohio	13.50	40,500	13.50	40,500
8	Ed. Phelan, Omaha, Nebr	11.50	34,500	11.50	34,500
9	R. H. McWilliams & Co., Chicago, Ill	13.75	41,250	13.75	41,250
10	Samuel Katz, Omaha, Nebr	10.50	31,500	13.00	39,000
11	Thompson & Gray, St. Louis, Mo	18.00	54,000	19.50	58,500
12	Jones & Strickler, Keokuk, Iowa	13.875	41,625		
13	S. A. Harrison & Co., Milwaukee, Wis	15.00	45,000		
14	J. A. Ware, St. Louis, Mo	9.19	27,570	13.37	40,236
15	John J. McCaughey, Summit, Ill	11.48	34,440	14.75	44,250
16	M. H. King & Co., Des Moines, Iowa	9.75	29,250	10.50	31,500
17	Mallory, Cushing & Co., Omaha, Nebr	12.45	37,350	13.45	40,350
18	N. P. Glann Cons. Co., Galesburg, Ill	14.00	42,000	15.60	46,800
19	A. J. Whitney, Rock Island, Ill	22.50	67,500	22.50	67,500
20	Penney-Myers Cons. Co., St. Louis, Mo	9.87	29,610	11.87	35,610
21	Patrick McDonell, Duluth, Minn	9.75	29,250	11.50	34,500
22	Henry Hall, Florence, Nebr	11.23	33,690		
23	C. H. Dameron & Bro., Huntsville, Mo	14.00	42,000	16.50	49,500

* Recommended for acceptance; accepted, and written contracts made.

Abstract of proposals received and opened by Lieut. Col. A. Mackenzie, etc.—Continued.

[There is available for the following works from appropriation of $1,500,000 made by the sundry civil act approved March 2, 1895, for "improving Mississippi River from mouth of Ohio River to Minneapolis," an allotment of $866,666.67 made by said act for "improving Mississippi River between mouth of Missouri and Minneapolis."]

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN GENOA AND PRAIRIE DU CHIEN, WIS.

[Allotment of $40,000 made by project approved April 17, 1895.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Volney A. Bigelow, La Crosse, Wis	$1.06	$27,000	19	$4,750	$31,750
2	Halvorson, Richards & Co., Minneapolis, Minn	1.10	27,500	40	10,000	37,500
3	A. B. Teasdale, Cassville, Wis	1.08	27,000	26	6,500	33,500
4	Jacob Richtman, Fountain City, Wis	1.20	30,000	25	6,250	36,250
5	Albert Kirchner, Fountain City, Wis.*	1.00	25,000	14	3,500	28,500
6	Sid. J. Truax, Hastings, Minn	1.39	34,750	49	12,250	47,000
7	Patterson Bros., Keokuk, Iowa	1.50	37,500	40	10,000	47,500
8	A. J. Whitney, Rock Island, Ill	1.00	25,000	31	7,750	32,750
9	James Short, St. Charles, Mo	1.12	28,000	16	4,000	32,000

* Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN DUBUQUE AND CLINTON, IOWA.

[Allotment of $40,000 made by project approved April 17, 1895.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Volney A. Bigelow, La Crosse, Wis	$1.15	$28,750	25	$6,250	$35,000
2	Halvorson, Richards & Co., Minneapolis, Minn	1.10	27,500	40	10,000	37,500
3	A. B. Teasdale, Cassville, Wis	1.16	29,000	28	7,000	36,000
4	Jacob Richtman, Fountain City, Wis	1.20	30,000	15	3,750	33,750
5	Albert Kirchner, Fountain City, Wis.*	1.00	25,000	14	3,500	28,500
6	Patterson Bros., Keokuk, Iowa	1.10	27,500	19	4,750	32,250
7	Sid. J. Truax, Hastings, Minn	1.50	37,500	49	12,250	49,750
8	A. J. Whitney, Rock Island, Ill	1.00	25,000	29	7,250	32,250
9	James Short, St. Charles, Mo	1.15	28,750	16	4,000	32,750

* Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN HAMBURG, ILL., AND CAP AU GRIS, MO.

[Allotment of $50,000 made by project approved April 17, 1895.]

No.	Name and address of bidder.	30,000 cubic yards rock in place.		30,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Kelly & Monroe, Portsmouth, Ohio	$1.19	$35,700	49	$14,700	$50,400
2	Halvorson, Richards & Co., Minneapolis, Minn	1.15	34,500	45	13,500	48,000
3	Jacob Richtman, Fountain City, Wis	1.10	33,000	30	9,000	42,000
4	Albert Kirchner, Fountain City, Wis	1.10	33,000	18	5,400	38,400
5	Sid. J. Truax, Hastings, Minn	1.25	37,500	60	18,000	55,500
6	H. S. Brown & T. S. Adams, Quincy, Ill	1.10	33,000	65	19,500	52,500
7	A. J. Whitney, Rock Island, Ill	1.10	33,000	50	15,000	48,000
8	James Short, St. Charles, Mo.*	.94	28,200	15	4,500	32,700

* Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN CAP AU GRIS, MO., AND MOUTH OF ILLINOIS RIVER.

[Allotment of $50,000 made by project approved April 17, 1895.]

No.	Name and address of bidder.	30,000 cubic yards rock in place.		30,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
				Cents.		
1	Kelly & Monroe, Portsmouth, Ohio	$1.15	$34,500	44	$13,200	$47,700
2	Halvorson, Richards & Co., Minneapolis, Minn	1.15	34,500	45	13,500	48,000
3	Jacob Richtman, Fountain City, Wis	1.10	33,000	25	7,500	40,500
4	Albert Kirchner, Fountain City, Wis	1.00	30,000	16	4,800	34,800
5	Sid. J. Truax, Hastings, Minn	1.10	33,000	75	22,500	55,500
6	H. S. Brown and T. S. Adams, Quincy, Ill	1.00	30,000	60	18,000	48,000
7	A. J. Whitney, Rock Island, Ill	1.10	33,000	50	15,000	48,000
8	James Short, St. Charles, Mo.*	.87	26,100	10	3,000	29,100

* Recommended for acceptance; accepted, and written contract made.

REPORT OF MR. J. D. DUSHANE, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 30, 1895.

MAJOR: I have the honor to submit the following report of operations under my direction for improving the Mississippi River between Minneapolis and Lake Pepin for the calendar year ending December 31, 1894:

MINNEAPOLIS TO ST. PAUL.

The river and harbor act of August 17, 1894, contained the following item pertaining to the improvement of this part of the river:

"Improving the Mississippi River between the Chicago, Saint Paul, Minneapolis and Omaha Railroad Bridge, at St. Paul, to the Washington Avenue Bridge, at Minneapolis, fifty-one thousand dollars, which, together with the unexpended balance standing to the credit of this improvement, shall be expended under the project or plan to extend navigation from St. Paul to the flour mills at Minneapolis, estimated for by Major Mackenzie, as appears by his report made to General Thomas L. Casey, Chief of Engineers, United States Army, under date of March first, eighteen hundred and ninety-four, by the construction of lock and dam numbered two in the same project."

Under project approved October 9, 1894, a survey was made for determining the exact site of Lock and Dam No. 2, and of the land needed for these works and the approaches thereto. The survey was extended from the site of the works to the upper limit of the flat above the Washington Avenue Bridge in order to ascertain the extent of overflow of land due to backwater from the dam at high water. A transit line and level were run on each side of the river. The survey was begun November 5 and completed December 14, 1894. The notes and maps are being worked up in the office. Mr. Rufus Cook had charge of the field work.

Plans and estimates will be prepared during the winter for commencing the construction of the foundation of Lock No. 2 during 1895, if the available funds, after acquiring the necessary lands, are sufficient for the completion of that part of the work.

Up to the close of the calendar year nothing had been done toward acquiring the lands at the site of the lock and dam.

The cost of surveys, etc., during the year was $2,113.36.

ST. PAUL TO LAKE PEPIN.

Under projects approved May 8, 1893, and August 31, 1894, work of building dams and shore protections, and of dredging channels, was continued between St. Paul and Lake Pepin by day labor and use of Government plant. Materials were secured by formal contract and by purchase in open market.

Building dams and shore protections.—Work was resumed September 10, 1894, in the vicinity of Diamond Bluff, on the construction of a series of brush and rock wing dams to rectify the channel, and on shore protections to protect caving banks. Towboat *Fury* and launch *Emily* were used for towing material on United States barges. Dams 9 to 24, inclusive (sheet 9*), were built, all being finished to a height of 5 feet above low water of 1864. Directly opposite Diamond Bluff, 1,743 linear feet of shore protection 39 feet in width was built. On the left bank a shore protection 5,120 feet in length and of 72 feet average width was built, extending from Dam 17 (sheet 9) to the mouth of the Trimbelle River; and below the mouth of the Trimbelle River, 2,200 linear feet of shore protection 46 feet in average width was built. All shore protections were carried to the top of the bank, generally about 10 feet above low water of 1864.

The object of the dams built at Diamond Bluff was to prevent the channel from being crowded down against the large rock patch, which was threatened by a moving bar above, and to correct the direction of the channel at the crooked and shoal crossing above town, where for a number of years much trouble has been encountered by boats and rafts at low stages of water.

Repairs were made to the Stockholm Harbor Pier (sheet 12) by placing 256.8 cubic yards of riprap rock around the end and sides of the pier to replace rock which had settled away and to protect the exposed timber crib from the action of drifting ice.

The following prices were paid for materials on United States barges: By formal contract made in 1893, for brush, per cubic yard, 29½ cents; by open market purchase: For brush, per cubic yard, 25 cents; for rock, per cubic yard, 47½ cents.

Several additional dams will be required to complete the series at Diamond Bluff; works of improvement should be built at Sturgeon Slough and at Prescott. The following series of dams should be extended: At Morgans Bar; at Smiths Bar; above Hastings; in the vicinity of Islands 14 and 15; at Robinsons Rocks, and at the Stock Yards. Shore protections should be extended at Pigs Eye, Grey Cloud, and Island 19. Much of the above work could be done advantageously at a moderately high stage of water.

Operations were discontinued for the season November 12, and the entire fleet was laid up in the winter harbor at Boulanger Slough, excepting towboat *Fury*, launch *Emily*, quarter boat 21, and barges 126 and 127, which were taken to South Stillwater for repairs, where the *Fury* and *Emily* were hauled out on the ways November 13.

Dredging channels.—Suction dredge No. 14, having been put in readiness for work at Keokuk during the early part of the season and delivered at Red Wing for service August 10, was employed in dredging channels as follows:

At Sturgeon Slough the dredge worked from August 14 to September 7 in cutting through a sand bar which during the prevailing low stage of water formed a very shoal crossing. A channel at least 4½ feet deep at low water of 1864, 100 feet wide, and 300 feet long was made. The sand pumped from this channel was conveyed through about 350 feet of 12-inch iron pipe to a small lake beyond the right bank of the river.

Above Diamond Bluff, between September 8 and 22, a temporary channel was cut through the upper end of a sand bar which formed a very crooked and difficult crossing. The sand pumped from this bar was conveyed through about 400 feet of pipe to a pocket behind a dry bar near the left bank of the river. From October 8 to November 2 dredging was continued at the same bar in the direct line of the proposed rectified channel; the material pumped—sand and sawdust—was conveyed through about 350 feet of pipe toward the right bank and deposited between the dams which were being built at this time.

On November 3 the dredge was moved to a gravel bar near the right bank above Diamond Bluff, where pumping sand and gravel and raising bowlders with grappling hooks were undertaken. This work was discontinued (uncompleted) November 5, owing to the cold and threatening weather. The dredging plant was laid up November 7 in Boulanger Slough.

Much loss of time was occasioned by passing boats and the partial failure of the worn-out hose which was used and by the breakage of the pump shaft. From September 23 to October 6 dredging was suspended owing to the utter failure of the suction hose—the new hose, which was ordered on August 18, not having been received until October 6. Dredge No. 14 was in service 89 days, and in operation (pumping) 315 hours.

Cost of dredging during the season was $4,118.49.

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* Sheet numbers are those of the general maps, survey of 1878–79.

List of works accomplished, and of materials used, during the season of 1894 between St. Paul and Lake Pepin.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1894.	Rock.	Brush.
Sheet 9:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Shore protection, right bank, opposite Diamond Bluff	1,743	.....	2,487.7	1,069
Shore protection, left bank, above Trimbelle River	5,120	.....	11,209.6	8,504.4
Shore protection, left bank, below Trimbelle River	2,200	.....	3,574.9	2,394.2
Dam 9	75	5	636.2	824.6
Dam 10	160	5	244.9	1,218.6
Dam 11	275	5	553.5	749.5
Dam 12	530	5	714.7	3,020.8
Dam 13	706	5	1,204.6	3,694
Dam 14	640	5	811.4	3,003.5
Dam 15	500	5	770.4	1,785.3
Dam 16	340	5	531.6	1,623.6
Dam 17	130	5	216.5	478.7
Dam 18	110	5	276.1	708.9
Dam 19	210	5	349.4	1,359.6
Dam 20	370	5	540.1	2,062.8
Dam 21	535	5	709.4	2,172.1
Dam 22	174	5	119.2	475.7
Dam 23	294	5	494	1,922.2
Dam 24	470	5	941.6	3,312
Sheet 12:				
Repairs to Stockholm Harbor Pier	.....	.....	256.8	.....
Total	.....	.....	26,642.6	40,319.5

Financial statement for work of improving the Mississippi River between St. Paul and Lake Pepin during the calendar year 1894.

Amount expended in field during the calendar year 1894 (from distribution sheets)	$39,088.02
Add cost of material from 1893	294.81
Total	39,382.83
Deduct retained percentage of 1893	719.26
Net cost of field work	38,663.57
Add quota of general superintendence and office expenses	882.48
Add for use and deterioration of plant	2,927.40
Total	42,473.45
Materials put in works:	
Rock ..... cubic yards	26,642.9
Brush ..... do	40,319.5
Total ..... do	66,962.4
Average cost per cubic yard—	
For materials on barges	$0.334
For towing and putting in place	.243
For general superintendence and office expenses	.013
For plant	.044
Average cost per cubic yard in place	.634

I take pleasure in referring to the able services of Mr. H. E. Clark, overseer, who was in immediate charge of this work.

SMITHS BAR TO LAKE PEPIN.

This work was continued under the project approved May 8, 1893, and a contract, dated August 8, 1893, with Jacob Richtman for the construction of shore protections between Smiths Bar and Lake Pepin, at $1.20 per cubic yard for rock and 40 cents per cubic yard for brush in place.

Operations were resumed June 13, 1894, and the contract was completed July 31.

Below the mouth of Sturgeon Slough (sheet 9), on the right bank, 5,160 linear feet of shore protection of an average width of 42 feet were built; and on the left bank, opposite the head of Island 25, there were built 920 linear feet of shore protection of

an average width of 44½ feet, extending from the protection of 1892 to Closing Dam 2 (sheet 10).

Mr. G. C. Saulez, overseer, continued to give this work excellent supervision.

List of works constructed and of materials used during the season of 1894 under contract with Jacob Richtman between Smiths Bar and Lake Pepin.

Designation.	Length.	Materials.	
		Rock.	Brush.
	Feet.	*Cu. yds.*	*Cu. yds.*
Sheet 9: Shore protection, right bank, at Sturgeon Bend	5,160	9,196.9	6,125.8
Sheet 10: Shore protection, left bank, opposite Island 25	920	1,326	1,132.7
Total	6,080	10,522.9	7,258.5

Financial statement for work between Smiths Bar and Lake Pepin performed under contract during seasons of 1893 and 1894.

Amount paid contractor	$43,971.84
Add cost of local inspection	1,060.98
Add quota of general superintendence and office expenses	1,111.15
Total	46,143.97
Materials put in works, 1893 and 1894:	
Rock, cubic yards	30,082.8
Brush, do	19,681.2
Total	49,764.0
Average cost per cubic yard in place	$0.927

SURVEYS.

A series of ten gauges was established between Minneapolis and St. Paul, and gauge readings were taken at frequent intervals for the purpose of determining the elevations of the water surface at these points between high and low water. The observations were begun May 20, 1894, when the U. S. Engineer gauge at St. Paul read 11.5 feet, and were continued until August 7, when the water surface stood at 0.16 on the same gauge. The river fell to 0.25 feet below the zero of this gauge on August 9, but no observations were taken above St. Paul.

A continuous detailed survey of the river was made from Hastings to Lake Pepin July 16 to August 18. A transit line was measured the entire distance—31 miles, 6½ miles of stadia lines were run locating side sloughs, and 835 lines of soundings were taken. A sufficient number of permanent monuments were placed to enable detached portions of the survey to be easily retraced.

The following gauge readings observed are believed to be the lowest on record:

St. Paul, U. S. Engineer gauge, August 9, 1894, 0.25 below zero.

Hastings, U. S. Engineer gauge, August 6, 1894, 0.77 below zero.

Red Wing, U. S. Engineer gauge, August 7, 1894, 0.42 below zero.

Zero on the above gauges indicates the accepted low water of 1864.

Very respectfully, your obedient servant,

J. D. DUSHANE, *Superintendent.*

Maj. A. MACKENZIE,
Corps of Engineers.

REPORT OF MR. W. A. THOMPSON, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 5, 1895.

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1894:

STOCKHOLM HARBOR, IN LAKE PEPIN.

Some slight repairs were made to the deck of the pier by the crew of the snag boat *General Barnard* and 257 cubic yards of rock were placed along the side of the pier to strengthen the foundation.

The cost of the above work was about $300.

REEDS LANDING TO GENOA.

(*a*) *Construction of dams and shore protection.*—The improvement of this section of the river—95 miles in length—by construction of dams and shore protection was carried on under projects approved September 19, 1893, and August 31, 1894. Work during the season was performed by hired labor and use of government plant with the exception of a few barges hired from private parties as the necessities of the work required. Towboat *Alert* and launches *Ada* and *Elsie* were used for towing. Material, loaded on United States barges, was purchased as follows: Sand rock at 53 cents per cubic yard, under formal written contract; by purchase in open market under public notice of ten days and sealed proposals, sand rock, at 42 and 45 cents per cubic yard, lime rock at 50 and 55 cents per cubic yard, and brush at 19¼ and 19$\frac{88}{100}$ cents per cubic yard. Sand rock at 45 cents per cubic yard, lime rock at 50, 60, 62, and 63½ cents per cubic yard, and brush at 22 cents per cubic yard were bought in open market, without sealed proposals.

Material left on hand at close of season of 1893 and used during season of 1894: Brush, 2,284.5 cubic yards at 24½ cents per cubic yard.

The first work done in this stretch of the river was in the vicinity of Chimney Rock, about half way between Minneiska and Fountain City. The construction of a series of wing dams from the east bank of the river was commenced late in the fall of 1893, but owing to the early closing of navigation the work was necessarily left unfinished. Trouble for navigators was to be expected unless the plan for the permanent improvement could be carried out before the river fell to its ordinary summer stage. Preparations were made during the spring for resuming work as soon as possible after the river had receded to a proper stage. The fleets in the harbors at La Crosse and Fountain City were thoroughly repaired, and on June 28 both fleets were taken to Chimney Rock, where the construction of the dams was commenced, work being continued until August 13, when operations were suspended on account of a more urgent need of work at other parts of the river. Work at the bars in vicinity of Chimney Rock was resumed October 22 and carried on until November 10, when the boats and barges were taken to winter quarters. During the latter part of the season dredge *Vulcan* was used to facilitate the improvement. The operations of this dredge are given further on. The result in the improvement work in the vicinity of Chimney Rock is very satisfactory. The width of the river at less than a 4-foot stage has been reduced to about 800 feet where before it was from 1,600 to 2,600 feet wide. Just before the improvement the steamboat channel was narrow and shoal at low stages and very crooked; it is now wide and straight and deep enough at the lowest stages for the largest class of steamboats on the Upper Mississippi River. The work performed at Chimney Rock during the season of 1894 consisted in the construction of one closing dam and ten wing dams, aggregating in length 8,434 feet.

During the months of July and August the river fell to a very low stage and was ower at many places than ever before recorded. The bars which presented the most serious trouble to navigators between Reeds Landing and Genoa were as follows: Below Alma, Mount Vernon, Head of Blacksmith Slough, Mount Trempealeau, La Moille, and Brownsville. There was for a time less than 3 feet of water in the steamboat channel at each of these bars. At most of these places but little, if any, improvement work had previously been done.

When these bars first became troublesome it was not considered advisable to stop work entirely at Chimney Rock, but on August 7 a part of the fleet at Chimney Rock, consisting of launch *Elsie*, six barges, one quarter boat, one grasshopper, and one building boat, was detached and sent to the bar below Alma. Wing Dams 22 and 23 (sheet 15), commenced in 1893, were raised and extended to the full length given in the approved project. Wing Dam 24 (sheet 15), from Minnesota shore, 1,270 feet below Dam 23, was also built. The total length of these dams is 1,199 feet. They were all built to a height of 4 feet above low water of 1864, and a good permanent channel was secured through this bar.

The above work was completed August 29 and the fleet taken to Mount Vernon. At this bar Wing Dam 4 (sheet 16) was raised and strengthened; Wing Dams 25 and 26 were built from Minnesota shore, above Wing Dam 4, and Wing Dams 29 and 30, also from Minnesota shore, were built below Dam 4. Old Trailing Dam 3 (sheet 16) was extended 1,500 feet. Two wing dams were built from the west side of the trailing dam. All of these dams were built to a height of 4 feet above low water of 1864, and by the construction of same the river was reduced in width to 800 feet. A good steamboat channel was secured as a result of this reduction in width, and no more trouble for navigation is expected at Mount Vernon Bar. The total length of the six new wing dams and the trailing dam is 5,053 feet. The work at Mount Vernon was completed October 22, and the fleet was then moved back to Chimney Rock, where it was employed until the close of the season, as mentioned before in this report.

The fleet that was used at Chimney Rock until August 13 was moved to Mount Trempealeau Bar. The work of constructing a series of wing dams from the right

bank was commenced August 14, and, with the assistance of dredge *Vulcan*, a good channel was made through this bar in a very short time. As more or less trouble had been experienced by steamboat men for years at this bar and at La Moille Bar, it was thought best to do the work on the line as proposed in the approved project. Accordingly, nine wing dams were constructed from the right bank of the river in the vicinity of Mount Trempealeau and La Moille, one wing dam from the west side of the head of Island 79, opposite La Moille, and four wing dams from the west side of Island 78. By these means the river was confined at low stages for a distance of about 2 miles to a width of about 800 feet, and a good permanent channel, deep enough for steamboats at low stages of water, was secured. The work of protecting the head of Island 78 was commenced, but not completed.

Total length of dams at Mount Trempealeau and La Moille bars, 7,820 feet; all built to a height of 4 feet above low water of 1864. Length of shore protection at head of Island 78,784 feet.

On September 25 the work of improving the river in vicinity of Blacksmith Slough and Homer Chute was commenced. In accordance with the approved project Blacksmith Slough was closed and the channel forced down Homer Chute along the Minnesota shore. In addition to the dam closing Blacksmith Slough, four wing dams were built from the Wisconsin shore above the slough, and to regulate the channel through Homer Chute eight wing dams were built out from the west side of Blacksmith Island and two wing dams from the Minnesota shore opposite the foot of Blacksmith Island; and to straighten the channel below Blacksmith Slough two wing dams were built from the Wisconsin shore. These dams were built to a height of from 3 to 4 feet above low water of 1864. The dam across Blacksmith Slough was not completed. The Wisconsin shore above the closing dam was protected for a distance of about 500 feet. The shore protection put in by the Chicago, Milwaukee and St. Paul Railway Company was repaired where damaged by the dredge in removing obstructing points above Minneowa. The total length of the dams built in vicinity of Blacksmith Island is 8,765 feet, and length of shore protection is 715 feet.

On November 10 all work of improvement between Reeds Landing and Genoa was suspended and the fleet put in winter quarters. One thousand six hundred and two and three-tenths cubic yards of brush were left on hand at close of season and banked in Fountain City Bay.

List of works constructed and repaired, and of materials used, during the season of 1894, between Reeds Landing and Genoa.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Brush.
Sheet 15:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 22, commenced 1893	304	4	309.9	1,267.1
Wing Dam 23, commenced 1893	630	4	1,094.5	5,539.2
Wing Dam 24	265	4	809	4,725.8
Sheet 16:				
Trailing Dam 3, extension	1,500	4	926.2	2,672.3
Wing Dam 4, raised and extended	665	4	838.6	2,476.2
Wing Dam 12, commenced 1893	1,700	4	1,439.7	6,475.6
Wing Dam 14	430	4	862.5	4,808.1
Wing Dam 15, commenced 1893	1,800	4	1,174.7	5,378.1
Wing Dam 18	230	5	424.9	1,840.3
Wing Dam 19, not completed	710	3	1,596.6	5,307.2
Wing Dam 20	450	4	718.2	2,242.6
Wing Dam 21	350	4	512.9	3,635.9
Wing Dam 22	660	4	1,469.7	4,262.8
Wing Dam 23, not completed	790	4	1,325.8	5,493.1
Wing Dam 24	400	4	574.7	1,953.7
Wing Dam 25	610	4	1,168.8	5,230.2
Wing Dam 26	335	4	820.1	3,413.2
Wing Dam 27	308	4	368.9	1,919.3
Wing Dam 28	350	4	659.2	3,457.7
Wing Dam 29	870	4	1,189.1	4,265.6
Wing Dam 30	1,080	4	1,484.6	5,959.9
Closing Dam 17	914	5	1,733.1	6,986.3
Sheet 18:				
Wing Dam 49	510	4	639.3	3,462.3
Wing Dam 50	520	4	983.4	6,571.9
Wing Dam 51, L-shaped	1,210	4	1,202.6	9,895.2
Wing Dam 52	840	4	473.2	3,552
Wing Dam 53	780	4	152	749.4
Wing Dam 54	520	3	426.9	2,135.3
Wing Dam 55	350	3	621	3,552.3
Wing Dam 56	500	3	256.3	1,487.5
Wing Dam 57	170	3	393.8	1,554.4

List of works constructed and repaired, and of materials used, etc.—Continued.

Designation.	Dimensions.		Materials.	
	Length.	Height above low water 1894.	Rock.	Brush.
Sheet 18—Continued.	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 58, L-shaped	580	3	1,084	4,333.1
Wing Dam 59	210	4	384.2	1,531.1
Wing Dam 60	210	4	82.7	946.6
Wing Dam 61	270	4	520.5	2,206.2
Closing Dam 1, not completed	500	4	1,561.1	5,821.1
Shore protection, east end Dam 1, Blacksmith Slough	385	.....	432	703.8
Shore protection, west end Dam 1, Blacksmith Slough	130	.....	221.9	451
Shore protection, head of Blacksmith Slough	200	.....	324	987.8
Chicago, Milwaukee and St. Paul R. R. embankment, repaired	.....	.....	34.9	.....
Sheet 19:				
Wing Dam 19, L-shaped	1,100	4	1,137.2	4,500.6
Wing Dam 20	1,380	4	1,521.7	5,566.4
Wing Dam 21	760	4	1,200.5	5,331
Wing Dam 22	600	4	667.3	2,930.7
Wing Dam 23	720	4	763.8	2,755.5
Wing Dam 24	720	4	603.7	1,621.3
Wing Dam 25	240	4	292.4	1,607.4
Wing Dam 26	700	4	1,199.2	5,225
Wing Dam 27	120	4	149.2	1,029.9
Wing Dam 28	120	4	126.3	361.6
Wing Dam 29	540	4	187.9	695
Wing Dam 30	290	4	274.7	754.7
Wing Dam 31	390	4	83.1	1,164.9
Wing Dam 32	140	4	151.8	571
Wing Dam 33	470	4	754.4	2,934.3
Wing Dam 34	525	4	712.9	3,770.4
Wing Dam 35	900	4	747.1	3,831.3
Shore protection Island 78, not completed	784	.....	234	912.6
Total	.....	.....	42,122.7	184,214.8

Financial statement for the work of building dams and shore protection between Reeds Landing and Genoa, performed by hired labor during season of 1894.

Amount expended in field during calendar year 1894, less $372.82, retained percentage of 1893 (from distribution sheets)	$101,678.94
Less cost of material on hand December 31, 1894	316.46
	101,362.48
Add cost of material on hand January 1, 1894	559.70
Net cost of field work	101,922.18
Add quota of general superintendence and office expenses	2,338.62
Add for use and deterioration of plant	7,326.24
Total	111,587.04
Material put in works:	
Rock, cubic yards	42,122.7
Brush, do	184,214.8
Total, do	226,337.5
Average cost per cubic yard:	
On barges	$0.276
For towing and putting in place	.174
For general superintendence and office expenses	.010
For plant	.033
Average cost per cubic yard in place	.493

(*b*) *Dredging.*—Towboat *J. G. Parke* towed dredge *Vulcan*, two dump boats, and one coal boat from Alton to Mount Trempealeau, reaching that place August 17. At this time a series of wing dams was being constructed from the Minnesota shore in vicinity of this bar, and to facilitate the opening of a channel for steamboats and rafts the dredge was employed from August 18 to August 24 in "casting" the

material dredged from the proposed channel. This material was carried away by the increased velocity of the current, caused by the dams decreasing the width of the river. On August 24, a channel sufficiently wide and deep for the passage of steamboats having been made, the dredge was taken to the right bank of the river above Minneowa to remove two obstructing rock points extending into the river from the railroad embankment. This work was completed August 29, and the work of removing the two temporary dams, Nos. 44 and 45 (sheet 18), below the lower Winona bridge was commenced but as the dredge was needed at Chimney Rock it was taken there August 31, before the dams were entirely dug out. On September 4 the towboat *J. G. Parke* returned to Alton and the raft boat *Verne Mac* was hired to take her place as a tender to the dredge. The dredge was employed at the bar in the vicinity of Chimney Rock the remainder of the season. Most of the material dredged was "cast" and carried away by the swift current.

On November 3 the dredge and dump boats were put into Fountain City Bay for the winter. On November 10 the tender was taken to Alma and turned over to her owner.

GENOA TO PRAIRIE DU CHIEN.

The work in this section of river, 49½ miles in length, was carried on under two contracts. The work principally consisted of the construction of closing dams across side chutes to confine the water to one channel at low stages.

First contract.—Under project of May 8, 1893, and allotment of $50,000, a contract, dated August 7, 1893, was entered into with Bigelow & Teasdale for the construction of rock and brush dams and shore protection, at $1.14 per cubic yard for rock in place and 40 cents per cubic yard for brush in place. Operations in 1893 were commenced August 18 and carried on until November 14, the close of navigation. Work was resumed April 2, 1894, and continued to May 1, when the contract was completed. In 1894 Closing Dam 1 (sheet 25) was built from foot of Island 138 to head of Island 139, and is situated about 2½ miles below Victory. The head of Island 139 was protected for a distance of about 300 feet. Closing Dam 9 (sheet 28) was built from Island 161 to 200 feet below the head of Island 163, across "Big Suck Off." Closing Dam 10 (sheet 28) was built across small slough about 1 mile above Dam 9.

List of works constructed and of materials used during season of 1894 under contract with Bigelow & Teasdale between Genoa and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 25:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 1	318	4	2,232.4	4,013.1
Shore protection, head Island 139	300	.....	619.3	876.8
Sheet 28:				
Closing Dam 9, across Big Suck Off	565	4	1,908.8	2,990.3
Closing Dam 10	250	4	736.4	875.5
Total	.....	.....	5,496.9	8,255.7

Mr. Louis Shaw was inspector in local charge of the work under contract with Bigelow & Teasdale in 1894.

Financial statement for work between Genoa and Prairie du Chien performed under contract with Bigelow & Teasdale in 1893 and 1894 (entire contract).

Amount paid contractors	$41,928.97
Cost of local inspection, etc	1,214.39
Add quota of general superintendence and office expenses	1,078.68
Add plant charge	82.40
Total	44,304.44
Material put in works, 1893 and 1894:	
Rock ..... cubic yards	26,003.4
Brush ..... do	30,712.7
Total ..... do	56,716.1
Average cost per cubic yard in place	$0.781

Second contract.—Under project of August 21, 1894, and allotment of $40,000, a contract, dated October 18, 1894, was entered into with Albert Kirchner, of Fountain City, Wis., for the construction of rock and brush dams and shore protection at $1 per cubic yard for rock in place and 39 cents per cubic yard for brush in place. Operations were commenced October 15 and carried on until the close of navigation, November 9. The works accomplished are as follows: Closing Dam 9 (sheet 28) was repaired and made stronger; Closing Dam 1 (sheet 27) was built across Ferry Slough, 350 feet below Island 148; work of building Dam 2 (sheet 27), across Capoli Slough, was commenced, but not completed.

Mr. H. C. Brice was the inspector in local charge of the work.

The contractor proposes to continue work under his contract during the winter.

List of works constructed and of materials used during the season of 1894 under contract with Albert Kirchner between Genoa and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 28:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 9, repaired and strengthened		4	2,068	2,215.4
Sheet 27:				
Closing Dam 1	216	4	1,259.3	1,091.7
Closing Dam 2, commenced			457.1	645 4
Total			3,804.4	3,952.5

Financial statement for work between Genoa and Prairie du Chien performed under contract with Albert Kirchner in 1894.

Amount paid contractor		$4,811.29
Retained percentage		534.59
Cost of local inspection, etc		585.86
Add quota of general superintendence and office expenses		136.44
Total		6,068.18
Materials put in works:		
Rock	cubic yards	3,804.4
Brush	do	3,952.5
Total	do	7,756.9
Average cost per cubic yard, in place		$0.782

SURVEYS.

A party in charge of Mr. H. C. Brice was employed during the early part of the season in making surveys and examinations of the river at various points where difficulties were being experienced or expected by steamboat men. Three surveys were made of the bars in vicinity of Chimney Rock to show the progress of the improvement work and its results. Examinations were made of the bars below Alma, at Mount Vernon, head of Blacksmith Slough, Homer Chute, Mount Trempealeau, Lamoille, head of Coon Slough and Raft Channel, and of the river in vicinity of De Soto. Maps of these surveys are now on file in this office.

On September 5 a party in charge of Mr. Louis Shaw was organized to make a survey of the river from the foot of Lake Pepin to Island 55, a distance of about 28 miles. The weather was extremely unfavorable for this survey, a dense smoke prevailing during the first two weeks, followed by fog and rain. Progress was also delayed by the large amount of topography taken. This survey was completed October 30.

On October 31 a survey from the Winona and Southwestern Railroad Bridge at Winona to Lamoille, a distance of 7¼ miles, was commenced, and the same was completed November 10, when the boats were put into winter quarters at mouth of Black River.

The notes of the surveys made by Mr. Shaw are now being platted at La Crosse, which work will soon be completed.

Cost of surveys made during season of 1894 was about $3,100.

Respectfully submitted.

W. A. THOMPSON, *Superintendent.*

Maj. A. MACKENZIE, *Corps of Engineers.*

REPORT OF MR. J. C. M'ELHERNE, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE, *Rock Island, Ill., January 30, 1895.*

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year December 31, 1894:

GLENHAVEN TO DUBUQUE.

Under project approved August 21, 1894, and allotment of $40,000, a contract dated October 18, 1894, was entered into with Albert Kirchner for the construction of dams and shore protection of rock and brush, at $1 per cubic yard for rock and 39 cents per cubic yard for brush, in place. No work was done in 1894.

DUBUQUE TO CLINTON.

Contract of 1893.—Under project approved May 8, 1893, and allotment of $50,000, a contract dated August 7, 1893, was entered into with Bigelow & Teasdale for the construction of brush and rock dams and shore protection, at 47 cents per cubic yard for brush and $1.24 per cubic yard for rock, in place. No work was done during season of 1893, as the contracting firm was busily engaged elsewhere on the river.

Active operations were commenced on May 3, 1894, and continued without interruption until the completion of the contract, September 22.

Mr. Louis Shaw was local inspector from May 3 to August 29 and Mr. C. A. Stoddard from August 29 to the completion of the contract.

For the purpose of retaining in its place the extensive bar above chute opposite Bellevue, closing head of this chute and providing a roadway for the ferry company, the old closing dam 2 (sheet 39) between upper end of Island 248 and the Illinois shore was raised, made 9 feet wide on top, and covered with spalls, to insure a safe crossing for wagons. The shore protection at each end of the dam was raised and repaired, and the head of the island itself protected from the dam around to the opposite shoulder. The average width of this protection is 40 feet. To close chute behind Santa Fe Island (sheet 41) a dam was built from north shoulder of this island to Illinois shore, and the head of the island then thoroughly riprapped to an average width of 50 feet.

As the long shoal crossing above mouth of Savanna Bay was badly in need of attention, two closing dams were put in; one between Islands 264 and 266 (sheet 41), and the other between Island 266 and its adjacent towhead. The head of Island 266 was repaired, and the towhead protected around its head and down channel side; width, 40 feet. Two wing dams were also run out from Island 264 well up abreast of the bar. The channel in that locality was thus finally drawn over toward the west side of the river, and a very satisfactory depth obtained.

In the vicinity of Island 287 (sheet 43), above Fulton, two very shoal crossings existed, on which boats and rafts frequently stranded. To force a good channel down east side, or Illinois shore of river, two closing dams were constructed, one from foot of Island 286 down to head of the willow towhead a short distance below, and the other from east shoulder of the willow island over to west shoulder of Island 287. The head of Island 287 was very heavily protected for a width of 50 feet.

On the completion of these dams the east channel was so much benefited that running the west side was entirely abandoned.

List of works constructed and repaired and of materials used during season of 1894, under contract with Bigelow & Teasdale, between Dubuque and Clinton.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864	Rock.	Brush.
Sheet 39:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 2, raised, widened, and repaired	.....	8	4,842.7	7,166.8
Shore protection, Island 248	320	.....	361.1	387.1
Sheet 41:				
Closing Dam 9	510	4	3,173.6	4,668.7
Wing Dam 10	955	4	2,928	3,917.4
Wing Dam 11	380	4	1,418.7	1,548.1
Closing Dam 12	115	4	688	790.3
Closing Dam 13	903	6	4,885.2	6,376
Shore protection, Island 263	940	.....	2,572.2	2,602
Shore protection, Island 266	455	.....	1,206	889.2
Sheet 43:				
Closing Dam 1	460	4	3,066.7	2,278.2
Closing Dam 2	675	4	2,971.4	2,678.2
Shore protection, Island 287	333	.....	1,419.8	928.4
Total	.....	.....	29,533.4	34,230.4

Financial statement for work between Dubuque and Clinton, performed under contract with Bigelow & Teasdale, during 1894.

Amount paid contractor		$52,709.69
Cost of local inspection, etc		1,138.06
Add quota of general superintendence and office expenses		1,238.50
Add for use and deterioration of plant		158.86
Total		55,245.11
Material put in works:		
Rock	cubic yards	29,533.4
Brush	do	34,230.4
Total		63,763.8
Average cost per cubic yard in place		$0.866

Contract of 1894.—Under project approved August 21, 1894, and allotment of $40,000, a contract, dated October 18, 1894, was entered into with Jacob Richtman for the construction of brush and rock dams and shore protection, at 20 cents per cubic yard for brush, in place, and $1.30 per cubic yard for rock.

Work was commenced on October 8, 1894, and suspended on November 10, and fleet laid up, as cold weather made its appearance, but was resumed, without the fleet, on December 13, and was being successfully carried on at the close of the calendar year. To further improve the shoal crossing opposite Island 287 (sheet 43), two wing dams were built out from that island across the west channel, thereby closing it entirely. As work progressed, the opposite, or Illinois shore, began cutting away rapidly, especially above Upper Cattail Slough. For the preservation of this bank a protection was begun at lower end of point, just above the slough, carried up river along the shore, and fairly well rocked for a width of 25 feet. The result of work so far done is a reasonably good channel along the Illinois side of the river.

Mr. C. A. Stoddard was local inspector.

List of works constructed and of materials used during season of 1894, under contract with Jacob Richtman, between Dubuque and Clinton.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 43:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 3	500	4	4,731.8	5,709.6
Wing Dam 4	475	4	2,575.5	2,209.2
Shore protection, Illinois shore	700	.....	1,114.9	1,465.3
Total	.....	.....	8,422.2	9,384.1

Financial statement for work between Dubuque and Clinton, performed under contract with Jacob Richtman, during season of 1894.

Amount paid contractor		$11,543.11
Cost of local inspection, etc		535.20
Add quota of general superintendence and office expenses		307.30
Add retained percentage on contract		1,282.57
Total		13,668.18
Material put in works:		
Rock	cubic yards	8,422.2
Brush	do	9,384.1
Total	do	17,806.3
Average cost per cubic yard, in place		$0.768

CLINTON TO LE CLAIRE.

From August 12 to 29, 1894, U. S. Drill boat No. 103 operated on dangerous rock reefs in mid-channel opposite Princeton. An area 50 feet wide by 404 feet in length, covering the obstructing points, was carefully sounded over, and one large patch

from one-half foot to 2 feet above grade, and two others of smaller size, were blasted. The broken material has not been removed, but should receive attention at an early date. The snag which on August 20 sunk the steamer *Verne Swain* in the channel below Albany was removed on the 24th.

There was 341.7 solid cubic yards of rock broken up, at a cost of $1,045.88, including superintendence and plant charge—an average of $3.06 per cubic yard.

ROCK ISLAND RAPIDS.

Necessary repairs having been made to the fleet, a portion of it proceeded on March 27, 1894, to Winnebago Chain, where active operations were immediately commenced.

Dams.—The experience of several seasons had shown that the dams so far constructed were not strong enough to effectually resist the pressure of ice gorges and floods. To obviate, if possible, the necessity of making frequent repairs, advantage was taken of a portion of the heavy dredged material to reenforce the dams already built.

The paving on Dams 6½, 8, 9, and 11, having sustained some damage in places, was thoroughly repaired, and the dams themselves were widened and strengthened.

Some material was deposited on a low place near west end of Dam 7. Dam 12 (new), at head of Smiths Chain, was built to a width of 8 feet on top and to a height of 2 feet above low water, extending out from small rock pile on Illinois side of channel, across head of old French Channel. This dam was built for the purpose of checking the strong draft of water through that chute, and the material dredged from Upper Chain was utilized in its construction.

Rock excavation.—Two steam-drill boats were employed during the season, with double crews, working sixteen hours per day. From March 27 to June 2 drill boat No. 103 operated on north side of Winnebago Chain on long high shoulder, where work was left unfinished in 1893. An area of 436 feet long by 96 feet wide, varying from one-half foot to 3 feet above grade, was carefully sounded and the obstructions were blasted. The boat was next placed on high patches on Illinois side of channel at foot of Upper Chain, at the point reached by the drill boat in 1893. Here an area 510 feet long by 158 feet wide, containing patches averaging from one-half foot to 2 feet above grade, was closely examined, and all obstructing rock was blasted by August 11. This boat was employed at Princeton from August 12 to 30. Between September 1 and October 18 three large patches in the pool above Moline Chain, which were much in the way of boats, were blasted, and later some scattering patches, from one-half foot to 1½ feet above grade, on Iowa side of channel below foot of Lower Chain, were thoroughly shattered.

Drill boat 6 arrived from below on July 3 and began work on southeast corner of long high shoulder on the north side of Lower Chain. Here a very rugged line of reefs existed, from 1 to 4 feet above grade, the water being so shoal in places as to render work on the ledges difficult. The area worked was over 1,500 feet long by 55 feet wide, and the blasting of the material occupied the entire working time of the boat during remainder of season.

Dredging.—On July 23 dredge *Ajax*, with double crew, was placed at lower side of large patches blasted on Illinois side of channel at lower end of Upper Chain. Having finished this work August 22, the boat was engaged until September 3 in taking out material left in 1894 at north side of Moline Chain and some high patches recently blasted at south side of same and in pool below Moline Chain. On September 4 the dredge commenced work on the heavy body of débris prepared by blasting at the north side of Lower Chain. The drill boat was overtaken on October 7, and the dredge, after removing some additional loose rock and bowlders discovered by "sweeping" in the vicinity of Moline Chain, was employed for the remainder of the season on the extensive patch at north side of Winnebago Chain.

Removing loose rock and bowlders.—Barge 27, fitted out with derrick, grapplings, and other appliances, rendered most excellent service in various localities. It was especially useful during the low-water period, when dangerous obstructions were suddenly discovered, and at times when the dredge was not available. The rocky bottoms of Upper and Moline chains previously dredged over, of the foot of Sycamore Chain, and of the lower end of Duck Creek Chain were carefully examined, and many high points and large rocks and bowlders met with, especially at Duck Creek, were blasted and removed, together with considerable loose rock. Much material pushed over on top of shoal reefs at Upper and Lower chains while blasting and dredging was taken away, and some of the large loose rock at Winnebago Chain was reblasted to permit of its being readily handled by the dredge.

Guide piers.—This work was commenced on August 24. Two piers were constructed: No. 16, on Illinois side of channel about midway between Winnebago Island and Mason Break, and No. 22, on south side of channel at head of Moline Chain. They were very substantially built up to elevation of high water, their average height being 17.2 feet, area of base 38 by 85 feet, and area of foundation 70

by 120 feet. In construction of the foundations dredged material was used, it being particularly well adapted to that purpose on account of its large size and weight.

Piers No. 11 and 24 received repairs where the action of the ice and floods had worn away some of the material from the foundations.

Operations were discontinued for the season on November 12, and the fleet was laid up in Moline Pool in charge of a watchman.

Details of operations.

Launch *Louise:*	
Hours working	1,114
Miles run light	1,423
Miles run towing	1,519
Miles run, total	2,942
Towboat *Mac:*	
Hours working	1,812
Miles run light	3,004
Miles run towing	2,295
Miles run, total	5,299
Drill boat No. 6:	
Hours working	1,724
Hours lost owing to rafts	11
Hours lost owing to accidents	0
Hours lost owing to storms	4
Holes drilled	3,449
Holes blasted	3,356
Linear feet of holes drilled	10,199
Range poles set in rock bottom	90
Ringbolts set	3
Solid cubic yards of rock blasted	2,837
Pounds of dynamite used	6,317
Drill boat No. 103:	
Hours working	2,755
Hours lost owing to rafts	24
Hours lost owing to accidents	90
Hours lost owing to storms	31
Holes drilled	4,829
Holes blasted	4,678
Linear feet of holes drilled	14,652
Range bolts set in rock bottom	151
Ringbolts set	2
Solid cubic yards of rock blasted	4,313
Pounds of dynamite used	9,802
Dredge *Ajax:*	
Hours working	1,420
Hours lost owing to rafts	5
Hours lost owing to accidents	72
Hours lost owing to storms	15
Solid cubic yards of rock dredged and removed	3,852
Cubic yards of loose rock and bowlders dredged and removed	6,464
Derrick barge No. 27:	
Hours working	440
Cubic yards of bowlders and ledges blasted	200
Cubic yards of bowlders and loose rock removed	470
Cubic yards of riprap rock taken from place of storage	430

Summary of total amounts of material.

Solid cubic yards of rock blasted	7,350.7
Solid cubic yards of rock dredged and removed	3,851.8
Cubic yards of loose rock and bowlders dredged and removed	6,934.2

Cost of rock excavation, including charge for use and deterioration of plant.

Locality.	Rock excavated, solid cubic yards.	Total cost.	Average cost per solid cubic yard.
Foot of Upper Chain, removed	1,295.7	.....	.....
Winnebago Chain, removed	455.0	.....	.....
Duck Creek Chain, removed	45.0	.....	.....
Foot of Moline Chain, removed	18.6	.....	.....
Lower Chain, removed	2,037.5	.....	.....
Total	3,851.8	$18,103.46	$4.70
Winnebago Chain, blasted only	1,236.1	.....	.....
Pool above Moline Chain, blasted only	1,256.8	.....	.....
Lower Chain, blasted only	1,006.0	.....	.....
Total	3,498.9	10,706.63	3.06
Grand total	7,350.7	28,810.09	.....

Cost of building new piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Average cost per cubic yard.
Slope-wall stone	456.3	$2,194.80	$4.81
Riprap stone	4,098.5	4,067.76	.99
Total	4,554.8	6,262.56	.....

Cost of building one pier $3,131.28

Cost of repairs to old piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Average cost per cubic yard.
Riprap stone	135.04	$133.99	$0.99

List of dams constructed and repaired, and of materials used, on Rock Island Rapids during season of 1894.

Designation.	Total length.	Filling, riprap.	Paving, riprap.
Sheet 47:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 6¼, extended and widened	830	844.7	30
Closing Dam 7, slightly repaired	980	61.7	.....
Closing Dam 8, widened and repaired	750	1,865.2	50
Wing Dam 9, widened and repaired	535	149	10
Wing Dam 11, widened and repaired	1,650	3,265.3	30
Wing Dam 12 (new)	277	3,043	.....
Total	.....	9,228.9	120

Cost of dams, including charge for use and deterioration.

Material.	Cubic yards.	Cost.	Cost per cubic yard.
Riprap stone in place	9,228.9	$9,159.68	$0.99
Paving stone in place	120	542.64	4.52
Total	9,348.9	9,702.32	.....

Average cost per cubic yard in place $1,038

Financial statement for improvement of Rock Island Rapids for season of 1894.

Amount expended in field	$38,159.24
Add quota of general superintendence and office expenses	877.66
Add for use and deterioration of plant	5,872.06
Total	44,908.96

Distributed as follows:	
1. Rock excavated and removed	18,103.46
2. Rock broken up but not removed	10,706.63
3. New guide piers (Nos. 16 and 22)	6,262.56
4. Repairs to old guide piers (Nos. 11 and 24)	133.99
5. Dams 6½, 7, 8, 9, 11, and 12	9,702.32
Total	44,908.96

ROCK ISLAND TO MUSCATINE.

To mark out the steamboat channel through the rock reefs in the vicinity of Island No. 316, the high points were sounded out by drill boat 6, and seven large, stout range poles with flags were securely set in rock bottom in that locality on August 18. A portion of the hull of the old steamer *Silas Wright* was removed during September from the channel opposite Davenport by derrick barge No. 27, which used dynamite so effectually as to completely shatter the wreck. A snag 2½ feet in diameter and 40 feet long, which was said to have nearly sunk the steamer *Cyclone*, was removed from edge of channel opposite head of Island No. 317.

BUOYS ON ROCK ISLAND RAPIDS.

The buoys, having been repaired and repainted, were reset June 17 to 21, 1894, with the exception of No. 17, which was replaced later in the season. Nos. 13½ and 26, being close to Guide Piers 12 and 24, respectively, were discontinued as unnecessary. During the season a new buoy (No. 17½) was, at the request of rapids pilots, placed on Masons Break. There are now twenty-nine buoys in the system. November 3 to 5, the range stakes having been repaired and readjusted, the buoys were taken up and stored for the winter.

The cost of buoyage for the season of 1894 was $347.08.

SURVEY.

On March 21, 1894, a party in charge of Mr. E. E. Barrett, surveyor, was put in the field in the vicinity of Savanna. From this point the survey, connecting with that of the previous year, was carried down to the head of Rock Island Rapids by May 9. The maps of above survey, made in the office at Rock Island, Ill., were completed in June.

Between June 25 and October 31 the same party made a continuous survey of the river from Rock Island to Montrose, and also special detailed examinations of Moline Water Power Pool, Rock Island Harbor, vicinity of Muscatine Bridge, vicinity of New Boston, vicinity of Keithsburg and Burlington Harbor. Maps of these surveys are now being prepared. Transit lines were run on the more suitable side of the main channel, and with the assistance of the stadia, sloughs and side chutes were examined.

Sounding lines were laid out on the main river, 300 feet apart, from Savanna to Cordova; 400 feet from Cordova to Le Claire; 50 to 100 feet in Moline Pool and on Rock Island Rapids; 100 feet from the bridge to the lower end of Rock Island, and 300 feet from there to Montrose. Soundings were located instrumentally. The special survey at Moline Pool was made to ascertain the amount of accretion during the year; those at Rock Island and Burlington for the purpose of determining the quantities of obstructing material that should be removed, and those at Muscatine, New Boston, and Keithsburg to locate troublesome rock patches or bowlders.

All available high-water marks and bench marks were connected with the survey, and elevations of water surface were taken at frequent intervals. Using river distances, the entire length of surveys made during the season is 166 miles. There were 234 miles of transit lines and 146 miles of stadia lines run, and 112,647 soundings taken.

The cost of surveys mentioned was $7,601.44.

Very respectfully, your obedient servant,

J. C. McElherne, *Superintendent.*

Maj. A. Mackenzie,
Corps of Engineers.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, February 1, 1895.

MAJOR: I have the honor to submit the following report of work performed under my direction between Keithsburg and Quincy, Ill., for the calendar year ending December 31, 1894:

KEITHSBURG TO NASHVILLE.

Dams and shore protections.—The work of building brush and rock dams, and also the operations of United States plant with towboat *Vixen*, was under the local charge of Overseer John R. Carpenter, from whose report extracts are given below. The stage of water was, as a rule, extremely low during the summer and fall of 1894. The worst obstructions above Keokuk were above Sauerweins, below the head of Benton Island, and the Keithsburg Rocks, which are now removed. The greatest channel depth on the crossings at each of these places was, at the lowest water of the season, about 3½ feet. The work was carried on by day labor and use of Government plant, the *Vixen* being used as towboat.

Work was commenced on September 18 in protecting shore above Sauerweins Bend, beginning 675 feet above Bench Mark No. 9 and connecting with old protection at Sauerweins Bend. The length of bank protected was 8,212 feet, and the work was finished October 24, when the fleet was moved to Otter Slough to repair Dams 1 and 4 (sheet 58). The water at Dam 1 had cut around the east end of the dam, making a gap 130 feet long and 13 feet deep at low water. Pile Driver No. 58 was put to work on the break October 25, and piles 26 feet long were driven to a depth of 8 feet. Considerable trouble was experienced on account of swift water and scarcity of material, but the break was closed, the shore protected above and below the dam, and the dam repaired on both sides, 140 feet of new capping being put on piling by November 8.

Dam 4, in Rush Chute, was also in bad condition, the piling in several places having been taken out by ice. Repairs were made by driving new piles and bolting on new cap. This dam was finished November 10. On account of low water the *Vixen* could not get to dams from upper side, and it was found necessary to employ the steamer *Climax* to drop barges from head of slough to dams.

On November 11 the fleet was taken to Island 396, opposite Devils Island, to finish protection commenced in 1892. One thousand four hundred and thirty-nine linear feet of bank was protected, commencing at old protection and running to lower end of island. This work was finished November 14, and fleet dropped down to finish shore protection above Montrose, uncompleted in 1893. On November 16 the fleet was taken into the canal for the winter, and the *Vixen* was put in the dry dock.

List of works constructed and repaired and of materials used during the season of 1894, between Keithsburg and Nashville.

Designation.	Length.	Material.		
		Rock.	Brush.	Piling.
Sheet 58:	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Lin. ft.*
Dam 1, repaired		2,196.8	682.5	830
Dam 4, repaired		1,210	173.3	504
Sheet 59:				
Shore protection above Sauerweins Bend	8,212	8,639.9	7,862.4	
Sheet 62:				
Shore protection, Island 396	1,439	599.8	416.4	
Shore protection above Montrose, completed		724.9		
Total		13,371.4	9,134.6	1,334

Financial statement for building dams and shore protections between Keithsburg and Nashville during season of 1894.

Amount expended in field during calendar year 1894 (from distribution sheets)		$16,853.46
Deduct retained percentage of 1893	$1,429.98	
Deduct cost of material on hand January 1, 1895	197.12	
		1,627.10
		15,226.36
Add cost of material on hand January 1, 1894		197.12
Add quota of general superintendence and office expenses		387.62
Add for use and deterioration of plant		1,963.50
Net cost of field work		17,774.60
Deduct cost of piling in place (1,334 linear feet, at 20 cents)		266.80
		17,507.80
Material put in work:		
Rock	cubic yards..	13,371.4
Brush	do....	9,134.6
Total		22,506.0
Average cost per cubic yard:		
On barges		$0.444
For towing and putting in place		.229
For general superintendence and office expenses		.017
For plant		.087
Average cost per cubic yard in place		.777

Removing rock from channel below Keithsburg.—The removal of several extensive patches of rock opposite the end of Dam 14 (sheet 55) was carried on by use of Government dredge *Phœnix*. The patches consisted mostly of small bowlders mixed with gravel and some sand, and are evidently of glacial origin. Under the bowlders was a stratum of bowlder clay extremely hard and tough and difficult to dig. A good channel 350 feet wide was made, but it is proposed to increase this to 500 feet by removing a few projecting points on the outside of the channel, which can be done at a comparatively small expense.

From the report of Mr. Byron Layton, in charge of operations of dredge *Phœnix*, the following extracts are made:

"September 17 the dredge began removing the rock and bowlders from channel below Keithsburg, and was engaged there until October 29.

"The rock patches below Keithsburg have always been a source of danger to steamboats, and the successive low waters of the last few years had made this more apparent, it being difficult for a steamboat of average draft to pass this point during the low water of this season without some damage.

"The average depth of water found on these patches was about 3 or 3½ feet at low water, but a few high points, with a depth of 2½ to 3 feet at low water, could always be found. The average size of the bowlders was small—from 1 cubic foot and less to 4 and 5 cubic feet, with an occasional one of from 1 to 2 cubic yards. The ledge rock was found in distinct patches, with deep water around them as a rule. Six feet at low water was established as grade for all area dredged over, and where it was possible this was secured; but it was found impossible to dig the tough gumbo found under all these patches, and in places this was found at a depth of 5 feet. The narrowest point in this channel is opposite Dam 13, where it is 400 feet wide; and to make the work complete this should be widened 100 feet. Careful soundings were made continuously after the dipper, and the channel was dragged with a rail and all points found above grade were located and removed, thus making us confident that the work done was thorough. Each patch was located from permanent instrument stations established by Surveyor Barrett.

"October 24 and 25 the dredge was engaged below the Keithsburg Bridge in removing some dangerous piling of the old Iowa Central Tramway, near the shore where the *Vixen* sank in 1891.

"*Removing rock at Des Moines Rapids.*—On April 2 drill boat No. 6, with Overseer Ed. Higgins in charge, was put at work on a bad patch of ledge rock opposite Solferino. On June 30 the fleet was towed to Rock Island by the *Vixen*, the work of blasting having been accomplished.

"Dredge *Phœnix* worked on the Solferino patch from June 14 to July 9, and on the 10th was occupied in removing some stray rocks from the channel below Millers Run. On the same day she was transferred to the district below Keokuk for work in the vicinity of Canton, Mo.

"October 29 the dredge was towed to Millers Run on the Des Moines Rapids, and was engaged there until November 15 in removing the blasted rock below Pier No. 4, just inside the upper red light. A small force of men was engaged in unloading the rock dredged and in building a pier 100 feet above and 50 feet inside the lower red light. This work was left unfinished, the cold weather compelling us to go into winter quarters November 15.

"The U. S. launch *Lucia* was used as tender for the dredge *Phœnix* from September 17 to 26, and the private steamer *Climax* was chartered for this purpose September 26 and was engaged until October 31. No steamboat was used while engaged on the rapids, the barges being handled by hand.

"There were removed by dredge from the channel near Keithsburg, 2,685 cubic yards of broken rock and 35 snags and piles; at Solferino, 190 cubic yards rock; at Millers Run, 507 cubic yards rock. In the course of blasting operations at Solferino and Millers Run 1,472 holes were drilled, aggregating 4,860 linear feet; 1,409 holes were blasted, and 3,279 pounds of dynamite used.

"The total cost of rock removed at Keithsburg and Des Moines Rapids in 1894 was $5,413.32, exclusive of charge for use and deterioration of plant."

KEOKUK TO QUINCY.

Most of the work in this stretch of river was done under contract. The day-labor work was conducted by Mr. John R. Carpenter, overseer, and the contract work under Inspectors Byron Layton and E. A. Sisson.

Contract of 1892.—Under an extension of contract dated November 7, 1893, Thompson & Gray worked from March 23 to June 6, 1894, when their contract was finished. The water was too high in 1894 between the dates given for advantageous work. The work done consisted in protecting 2,350 feet of bank below and 955 feet of bank above Gregorys Landing, besides 1,280 feet of bank on the Illinois shore above Hackley Island. Dam 5 (sheet 64), 1,350 feet long, was built in extension of the system of dams begun in 1893 for improving Lower Bludsoe Crossing. Dam 3 (sheet 63), at head of Fox Slough, was raised to about 3 feet above low water, and some repairs were made to the shore protection on the Missouri end of dam.

On May 17 the contractors' fleet was moved to Canton to raise Canton Chute Dam (No. 1, sheet 66), being engaged here until June 6. The repairs made to this dam were as follows: Piles were driven 4 feet apart and capped; a mat was then sunk broadside against the piling to check the current, and the dam was built up of rock. About 600 feet of this dam was built to a 6-foot stage by the contractor, when the work was closed on account of high water, and the contractors were released from further work on their contract, the dam afterwards being completed to a 7-foot stage by day labor.

List of works constructed and repaired and of materials used during the season of 1894 between Keokuk and Quincy under contract of 1892.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 63:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 3, repaired		3	157.4	
Sheet 64:				
Dam 5	1,350	5	2,563	4,242
Shore protection, vicinity of Gregorys Landing	3,305		5 202.9	2,767
Shore protection at Lower Bludsoe	1,280		2,100.7	1,423
Sheet 66:				
Dam 1, rebuilt			4,241.9	396
Total			14,265.9	8,818

Financial statement for work between Keithsburg and Quincy performed under contract with Thompson & Gray during 1892–1894.

Amount paid contractors		$91,169.87
Add cost of local inspection, etc		2,098.57
Add quota of general superintendence and office expenses		2,324.47
Add plant charges		432.81
Total		96,025.72
Material put in place:		
Rock	cubic yards..	52,828.5
Brush	do....	39,989.0
Total		92,817.5
Average cost per cubic yard in place		$1.035

Repairs to Canton Chute Dam, etc.—On June 14 Overseer John R. Carpenter took charge of the repairs to Canton Chute Dam, using dredge *Phœnix* and towboat *Vixen*. Rock was furnished by Thompson & Gray under open-market purchase at 58 cents per cubic yard. The piling cap of the dams was put on by agreement with H. S. Brown, of Quincy, Ill. Two hundred and ninety-six cubic yards of brush were bought in open market to cut off the water and keep the stone from being carried away by the violent current. The pile driving was done in very swift water on the crest of the dam, and afterwards pile driver No. 58 was rigged with shears to lift a great accumulation of logs and other drift over the dam—the result of a flood in the month of May. The drift massed itself in the piling in great quantities and required much labor for its removal.

Dredge *Phœnix* was employed digging gravel for tightening and strengthening the body and ends of Dam 1. The gravel was found in good quantity and quality within a few hundred feet of the dam, and was dumped in place on its upper face to the amount of 2,370 cubic yards.

On account of low water it was found impossible to finish the Smoot Chute Dam (No. 2, sheet 66); the piling and cap are finished, but there will have to be about 1,000 cubic yards rock put on its crest to bring it to grade and make it safe.

Financial statement for work of making repairs to Canton Chute Dam performed by hired labor during season of 1894.

Amount expended in field during the calendar year 1894 (from distribution sheets)		$5,347.83
Add quota of general superintendence and office expenses		123.00
Add for use and deterioration of plant		898.45
Total		6,369.28
Deduct cost of piling in place (8,548 linear feet, at 20 cents)	$1,709.60	
Deduct cost of dredging (2,370 cubic yards)	355.50	
		2,065.10
Total cost of rock and brush in place		4,304.18
Material put in works:		
Rock	cubic yards..	3,359.1
Brush	do....	296.0
Total	do....	3,655.1
Average cost per cubic yard:		
On barges		$0.549
For towing and putting in place		.349
For general superintendence and office expenses		.034
For plant		.245
Average cost per cubic yard in place		1.177

Contract of 1894.—Under contract with Jacob Richtman dated October 18, 1894, the steamer *Col. Patterson* and barges began work October 1 at the bad crossing below Alexandria, Mo., known as Upper Bludsoe Bar. Two thousand two hundred and fifty feet of shore protection were built on the Illinois shore, and Dam 6 (sheet 63)—the lower one of a series of three dams—was constructed. The work was closed November 12, on account of the cold weather.

List of works constructed and of materials used during season of 1894 between Keokuk and Quincy under contract with Jacob Richtman.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 63:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 6	1,492	5	5,731.5	5,420
Shore protection on Illinois shore at Bludsoes	2,250	.....	4,753.7	2,771.5
Total	.....	.....	10,485.2	8,191.5

Financial statement for work between Keokuk and Quincy performed under contract with Jacob Richtman during season of 1894.

Amount paid contractor	$13,742.15
Add retained percentage on contract	1,526.91
Add cost of local inspection, etc	340.89
Add quota of general superintendence and office expenses	359.03
Total	15,968.98
Material put in place:	
Rock ..... cubic yards	10,485.2
Brush ..... do	8,191.5
Total	18,676.7
Average cost per cubic yard in place	0.855

Removing snags and wrecks and deepening channels between Keokuk and Clarksville.—During the months of July and August the stage of the river became so low that it was necessary to put the dredge *Phœnix* at work opening channels through the worst places in order to keep up continuous navigation. The operations of the dredge and towboat *Vixen* were in charge of Overseer John R. Carpenter, whose report is quoted below:

"The worst place between Keokuk and Quincy was at Wyaconda Bar, above La Grange. Only 3 feet of channel water was found at this place. A cut was made through the bar in July, and afterwards deepened. A barge wreck at the Canton Landing was removed, as also the wreck of the steamer *W. H. Denny*, sunk in 1856, 5 miles below Quincy. The dredge spent considerable time in deepening the channel at Saverton, where existed the worst bar between Quincy and Clarksville. A cut 800 feet long and 60 feet wide was made, but navigation through the cut was difficult on account of cross currents. Snags to the number of 30 were removed at various localities. The estimated amount of sand dredged is 43,500 cubic yards.

"Cost of work in removing snags and wrecks and in deepening channels between Keokuk and Clarksville, in July and August, 1894, exclusive of plant charges, and in addition to $738.20 paid by snag boat appropriation, was $1,869.24."

IMPROVING QUINCY BAY.

Work was continued by Contractor H. S. Brown on the pile bulkhead at Whipple Creek. He began work April 2, as soon as the water was high enough to float his pile drivers and dredge. The dredge finished the graveling of the bulkhead June 4, 1894, and the contract was closed.

In dredging the gravel a cut was made extending diagonally from the upper end of the bulkhead toward the bay, above the shoal at the mouth of Whipple Creek, with the intention of leading the water of the creek as far as possible away from the dredged channel. A part of the gravel dredged was used to build a dike from the north end of the timber bulkhead, in extension of the same on high ground, forming a more extensive inclosure and protecting the cut between the upper and lower bay.

During the fall months some unknown persons put on teams and scrapers and connected this dike with the Illinois shore, raising the dike itself considerably and obliterating the drainage ditch, which had been dug as above stated. A portion of this dike will have to be removed, lest it force the water over the bulkhead itself into the cut, which it was built to protect.

One hundred and sixty-four linear feet of bulkhead were built, and a few of the clusters and spur piles were driven. The extension of the bulkhead built of gravel measured 200 feet in length.

Under open-market agreement with H. S. Brown, of Quincy, Ill., dated July 22, 1893, the balance of the allotment, after finishing the bulkhead, was used in deepening and extending the cut outside of the bulkhead northward. One cut 250 feet long was made northward, and a second cut about 80 feet long, parallel to it, when the appropriation was exhausted June 19 and the work discontinued. The cut outside the bulkhead remained navigable during all but the lowest water, until the close of the season.

At various dates the launch *Lucia* was run through the cut, and logs were brought down from the upper bay. At extreme low water the depth of the cut at the upper end was 2 feet, just enough to let a very light-draft boat through.

The pile bulkhead at Whipple Creek, Quincy Bay, consists of piling driven 4 feet apart, supporting two waling pieces bolted thereto, against which rest 3 by 12 inch sheet piles. All piling was driven in alluvial mud mixed with gravel and bowlders, from 6 to 12 feet in depth. The bulkhead thus made is protected from scour by gravel on both sides 4 feet deep, placed by dump boats at high water, and afterwards scraped into uniform shape by teams during low water. The shape of the bulkhead is an L, extending 1,300 feet up and down the bay, and a section of 350 feet connecting the lower end of this portion with the east shore. Its object is to protect a dredged channel through the shoal at the mouth of Whipple Creek, which formerly was filled up after every rainstorm by the heavy deposits of Whipple Creek, which swept across the cut at right angles.

An extension of the bulkhead 200 feet long, built of gravel alone, with slopes of 1½ to 1 and about 4 feet on the crest, together with the bulkhead proper, nearly incloses an area of 17½ acres, which is designated as a settling pond to retain the heavy deposits of the creek. The crest of the bulkhead is placed at 10 to 13 feet above standard low water, the higher portions, 450 feet long, lying opposite the mouth of the creek, where the gravel bar was much higher than above or below.

The completed structure contains—

White-oak piling	linear feet..	15,821
Sheet piling	feet, B. M..	66,933
Waling	do....	26,954
Gravel filling	cubic yards..	5,496

The improvement consisted further in dredging a practicable channel along and outside of the bulkhead to connect the north and south portions of Quincy Bay. This channel has been dredged to a useful depth, but much more excavation will be required before it will become a good channel. At present it is, at the upper end, not more than 2 feet deep at extreme low water, and will have to be widened and deepened.

In this dredging work there were removed, from August 7, 1893, to June 19, 1894, 20,949.3 cubic yards of mud, making a channel 80 to 100 feet wide, 2,000 feet long, and of a least depth at the upper end of 2 feet at low water.

Financial statement for improving Quincy Bay during season of 1895.

Amount paid contractor on account of pile bulkhead	$7,631.66
Lumber, day labor, etc., on pile bulkhead	104.12
Total expended on pile bulkhead	7,735.78
Dredging mud, 20,949.3 cubic yards, at 15 cents	3,142.40
Superintendence and office expenses	1,109.37
Total	11,987.55

SURVEYS.

Examinations were made during the season at Fox Island, at Bludsoes, and Wyaconda bars.

Very respectfully, your obedient servant,

M. MEIGS,
U. S. Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers.

REPORT OF MR. S. EDWARDS, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1895.

MAJOR: I have the honor to submit the following report of operations for improving Mississippi River in the division in my local charge, for the calendar year ending December 31, 1894:

QUINCY BRIDGE TO CLARKSVILLE.

The work between Quincy Bridge and Clarksville was carried on by day labor and use of Government plant, towboat *Coal Bluff* and launch *Stella* doing the towing. Work was carried on in the vicinity of Saverton, Turtle Island, and Quincy.

Vicinity of Saverton.—The crossing at this point has for years been bad, but perhaps never so bad as during the past season. Even at a fair stage of water the crossing was a difficult one, and at a 2-foot stage there could be found but little over 3 feet of navigable water. The reef, semicircular in form, extended from the Missouri shore to Island 445, closing the river entirely. During the summer relief was sought by dredging a channel through the bar at lower end of Saverton, and though this helped steamboats for a short time, it did not improve navigation for rafts. It was decided to build two dams (numbered 3 and 4, sheet 72), located, respectively, 2,800 and 1,175 feet below Island 445, extending from Illinois shore, each about 1,600 feet long; but owing to the fact that a navigable channel must be produced immediately, even if not permanent, the dams were run out only to the reef, making the lengths 1,090 and 1,050 feet, respectively. Rafts came down during and after the construction of the work and found no difficulty in making the crossing. At no time was there less than 4½ feet of water after the dams were completed. To make the channel permanent, these dams should be lengthened to 1,600 feet, and one wing dam and one closing dam built below them. The dams designed for the Missouri side may then be omitted. Dam 3 (sheet 72) was commenced September 12 and completed October 7; Dam 4 (sheet 72) was commenced September 20 and completed October 18.

At Turtle Island.—Work at this point was commenced October 8 and discontinued November 20, when the fleet was taken into winter quarters. The work consisted in building 1,690 feet of shore protection on Turtle Island (439), thus completely protecting the west bank of this island.

Dams 5 and 6 (sheet 70), commenced in 1893, were completed. The work of raising Dam 6 from low water of 1864 to 5 feet above was easily performed, but the raising of Dam 5 from 5 feet below low water to 6 feet above was slow and difficult. The closing of the old channel forced the whole river to the west of Turtle Island, and the cutting being slow the current at the dam was terrific. The use of a grasshopper had to be discontinued and the dam raised by building piers of brush and rock. The piers were made 20 feet apart. After thus going over the 840 feet the spaces were filled in, and the water having raised to overflow the dam the operation was repeated. To illustrate the strength of the current I need only state that in unloading rock the barges below the dam had to be pushed "full stroke" by the towboat *Coal Bluff*, and, in addition, two capstans used on building barge were required to hold them in place. This of course caused the towboat to lose much time. Notwithstanding the strong current, the use of brush in building piers prevented any loss of rock. After bringing the dam to grade a covering of brush was laid on top, loaded with rock on tips only. It is hoped this will prevent the ice from taking off any rock when going out.

Slight repairs were made to Dam 8 (sheet 70). Shore protection on Bay Island, opposite head of Turtle Island, was commenced, but as all hands were needed on Dam 5 work of shore protection was discontinued to be resumed in 1895.

Vicinity of Quincy.—Work at this point was begun October 20 and completed October 30, and consisted in repairing Dams 1 and 2 (sheet 68), opposite city of Quincy. The ends of the dams had been scoured off by running ice 160 and 360 feet, respectively, and from 0 to 13 feet deep. Both dams were extended to their original length, and the height of extensions was made the same as remainder of dam. In addition to this an apron 150 feet long was laid on outer end, rocked at tips only, to act as an ice breaker and prevent the abrasion of the ends of the dams by running ice. A small force was used on the above work, the launch *Stella* doing the towing.

In general.—I would say that in addition to ordinary difficulties, such as low water and consequent shallow channel, we were compelled to tow nearly all material up stream from 20 to 30 miles. Much delay and resulting expense was caused by my being unable to obtain authority to purchase material in advance of commencement of work.

Prices paid for rock ranged from 49½ cents to 62 cents and for brush 22 cents to 30 cents.

List of works constructed and repaired and of materials used during season of 1894 between Quincy Bridge and Clarksville.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 68:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 1, outer end rebuilt	160	.....	625.2	302.9
Wing Dam 2, outer end rebuilt	360	5	707.5	474.1
Sheet 70:				
Wing Dam 5, raised, completed	.....	6	6,248.1	5,184.1
Wing Dam 6, raised, completed	.....	5	1,263.3	1,774.9
Shore protection, Island 429, completed	1,690	.....	2,617.1	2,512
Shore protection, Bay Island, not completed	.....	.....	326.9	364.9
Wing Dam 8, repaired	.....	.....	50	523.1
Sheet 72:				
Wing Dam 3, not full length	1,090	4.5	3,767.4	8,877.6
Wing Dam 4, not full length	1,050	4.5	3,111.9	6,592
Total	.....	.....	18,717.4	27,105.6

Financial statement for work between Quincy Bridge and Clarksville, performed by hired labor during season of 1894.

Amount expended in field during calendar year 1894 (from distribution sheets)	$30,444.16
Deduct retained percentage of 1893	411.36
	30,032.80
Add quota of general superintendence and office expenses	690.76
Add for use and deterioration of plant	4,107.28
Total	34,830.84
Material put in works:	
Rock, cubic yards	18,717.4
Brush, do	27,105.6
Total	45,823.0
Average cost per cubic yard:	
On barges	$0.351
For towing and putting in place	.304
For general superintendence and office expenses	.015
For plant	.090
Average cost per cubic yard in place	.760

QUINCY BRIDGE TO HANNIBAL.

Under project approved July 27, 1893, and allotment of $50,000, a contract dated September 7, 1893, was entered into with Patterson Bros., of Keokuk, Iowa, for the construction of dams and shore protections between Quincy Bridge and Hannibal, at $1.09 per cubic yard for rock and 43 cents per cubic yard for brush in place. Work was commenced October 12, 1893, discontinued November 16, 1893, resumed April 21, 1894, and completed July 23, 1894.

During season of 1894 two closing dams were built in Fabius Slough, viz, Dams 5 and 6 (sheet 68). Dam 5 extends from Island 431 to Missouri shore and Dam 6 from Island 429 to Missouri shore. A very successful scouring was produced east of Orton Island and the channel thereby much improved. Five wing dams and one closing dam were built opposite Turtle Island (439). On Turtle Island 1,787 linear feet of shore protection were built and slight repairs were made to old shore protection on the island and on main shore above Hannibal Bridge.

This work, together with the work done by the United States fleet later in the season, completes the work projected at this point for forcing the channel to the west of Turtle Island.

List of works constructed and repaired and of materials used, between Quincy Bridge and Hannibal.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 68:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 5	937	5	6,683.1	5,264.6
Closing Dam 6	704	5	3,864.7	3,105.1
Shore protection, Orton Island, repaired			141.5	
Sheet 70:				
Closing Dam 7	252		447.6	382.4
Wing Dam 8	900	5	1,748.2	1,615.8
Wing Dam 9	900	4.5	2,087	2,130.9
Wing Dam 10	740	4.5	2,359.7	2,062.4
Wing Dam 11	500	4.5	1,051.4	778
Wing Dam 12	500	4.5	1,322.1	987.2
Shore protection, Turtle Island	1,787	12	4,056.9	1,840.3
Shore protection, Illinois shore, above Hannibal, repaired			496.4	
Total			24,258.6	18,166.7

Financial statement for work between Quincy Bridge and Hannibal, performed under contract during 1893–94 (entire contract).

Amount paid contractor	$41,708.92
Cost of local inspection, etc	1,353.37
Add quota of general superintendence and office expenses	1,010.83
Add plant charge	76.16
Total	44,149.28
Material put in works:	
Rock, cubic yards	29,884.6
Brush, do	21,243.5
Total	51,128.1
Average cost per cubic yard in place	$0.864

HANNIBAL DIKE.

The appropriation for rivers and harbors, of July 13, 1892, contains the following clause:

"*Provided*, That the Secretary of War be, and he is hereby, authorized to pay out of said appropriations the value of work actually done by the Hannibal Ferry Company, not exceeding the sum of two thousand one hundred and seven dollars and fifty cents, on the Upper Mississippi River Government dike, opposite Hannibal, Missouri, during the months of September, October, and November, eighteen hundred and ninety-one."

The dike referred to is Dam 3 (sheet 71), built by the United States in 1883 for the purpose of improving navigation at this point, and since used as a ferry landing by the above company.

The Hannibal Ferry Company claimed to have raised and strengthened the dike by the use of—

2,000 cubic yards of earth, at 10 cents	$200.00
1,366 cubic yards of rock, at $1.25	1,707.50
1,333 hours labor in unloading teams and placing rock, at 15 cents	199.95
Total	2,107.45

A formal examination of the dike and the work done by the ferry company was made in December, 1893, but owing to the fact that the dike was partly covered by sand an exact estimate of work actually done could not be obtained. There was evidence, however, that the material above mentioned had been used. Sworn statements of all parties connected with the work were obtained to verify the claim of the company.

Your report of December 23, 1893, stating that, in your opinion, the account is for "value of work actually done by the Hannibal Ferry Company," was approved by the Secretary of War January 3, 1894, as recommended by the Chief of Engineers,

(1) Financial statement for work between Hamburg and Cap au Gris, performed under contract during seasons of 1893 and 1894 (entire contract of 1893).

Amount paid contractor		$72,147.50
Cost of local inspection, etc		3,634.76
Add for general superintendence and office expenses		1,842.83
Add for use and deterioration of plant		221.59
Total		77,846.68
Material put in works:		
Rock	cubic yards	41,320.8
Brush	do	40,993.0
Total		82,313.8
Average cost per cubic yard in place		$0.946

(2) Financial statement for work between Hamburg and Cap au Gris, performed under contract during season of 1894 (contract of 1894).

Amount paid contractor		$6,637.49
Add estimate for December, 1894		7,480.55
Add retained percentage		1,568.67
		15,686.71
Cost of local inspection, etc		605.24
Add for general superintendence and office expenses		374.72
Total		16,666.67
Material put in works:		
Rock	cubic yards	12,344.6
Brush	do	8,731.9
Total		21,076.5
Average cost per cubic yard in place		$0.791

CAP AU GRIS TO ILLINOIS RIVER.

Contract of 1893.—Work was commenced April 19, 1894, under contract with James Short, dated August 7, 1893, and continued without interruption until October 10, 1894, when contract was completed.

Closing Dam 5 (sheet 81), which had been commenced under contract with Jacob Richtman, was completed. Wing Dam 4 (sheet 81), from foot of Island 501, opposite Cap au Gris, Closing Dam 8 (sheet 83) in Masons Chute, and Closing Dam 9 (sheet 83), from head of Iowa Island, were constructed. Thorough repairs were made to Dam 2 (sheet 81) and Dam 6 (sheet 81); also slight repairs to shore protectionon Island 499.

Contract of 1894.—Under an allotment of $50,000, in accordance with project approved August 21, 1894, a contract, dated October 18, 1894, was entered into with Jacob Richtman for continuing improvement of this section by construction of dams and shore protections. The prices to be paid for material in place are $1.10 per cubic yard for rock and 10 cents per cubic yard for brush.

Two hundred and twenty-five linear feet of shore protection at Auers Landing was constructed under above contract, work on which was commenced December 17, 1894, and was in progress at close of calendar year. Six hundred and twenty-two and five-tenths cubic yards of rock and 1,874.9 cubic yards brush were used, but no payments were made during the year.

Further details as to character and extent of the work done are given in "outline sketches showing work accomplished," which have been submitted, and in the following table:

List of works constructed and repaired and of materials used during the season of 1894, under contracts with James Short and Jacob Richtman, between Cap au Gris and mouth of Illinois River.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 81:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 2, repaired			2,453.6	664.2
Dam 5, completed	620	4	4,376.7	2,809.2
Dam 4	2,900	5	16,543.8	15,159.5
Shore protection, Island 499, repaired			758.6	260
Sheet 83:				
Dam 6, repaired			2,840.5	3,201.6
Dam 8	560	6	4,769.2	5,322.2
Dam 9, commenced			3,628.9	3,390.4
Shore protection at Auers Landing	225		622.5	1,874.9
Sheet 84:				
Dam 7, repaired			160.2	
Total			36,154	32,682

Financial statement for work between Cap au Gris and mouth of Illinois River, performed under contract of 1893, during season of 1894 (entire contract).

Amount paid contractor	$57,614.18
Cost of local inspection, etc	1,892.90
Add for general superintendence and office expenses	1,368.66
Add for use and deterioration of plant	130.90
Total	61,006.64
Material put in works:	
Rock, cubic yards	35,351.5
Brush, do	30,807.1
Total	66,338.6
Average cost per cubic yard in place	$0.92

ILLINOIS RIVER TO MISSOURI RIVER.

Under an allotment of $80,000, in accordance with project approved August 31, 1894, work was carried on in this section by day labor and use of Government plant, the materials being secured by purchase in open market.

Before commencement of construction work a portion of the plant was employed in vicinity of Hop Hollow, about 2 miles above Alton, where a bar had developed into an obstruction to navigation. On the 17th of August two barges were floated down from Piasa Chute and sunk upon crest of bar in a position to induce a scour near the Illinois shore. By this means an immediate improvement in depth of channel was effected, though not sufficient to meet the requirements of navigation. To afford additional relief a sand pump was chartered on August 20 and set at work. Pumping was continued until the end of the month and the desired temporary improvement of channel secured.

Work for remainder of season consisted in the construction of dams and shore protections. All works constructed in 1893 at and near Piasa Island were found in excellent condition, requiring no immediate repairs or extension and giving evidence of favorable effect upon the channel in their vicinity.

Construction of wing dams from Missouri shore, opposite Hop Hollow, was commenced September 17; also the driving of piles for closing dam at Portage Chute and the laying of shore protection on channel side of Piasa Island. On October 6 a gang was put at work building shore protection on Missouri shore opposite Maple Island.

The following work (all in sheet 84) was accomplished: Three wing dams, Nos. 13, 14, and 16, were built opposite Hop Hollow, extending from Missouri shore; Dams 17 and 18 were built out from Illinois shore at Hop Hollow; Dams 19 and 20 were constructed on channel side of Piasa Island, the former just below Dam 8, built in 1893, and the latter next in series below and at head of the shore protection

built in 1894. A pile dam (No. 15) was constructed at Portage Island, closing Portage Chute.

Shore protection on Piasa Island was built from foot of island, extending upstream a distance of 2,600 feet, with an average width of 70 feet. Mat in water 40 feet wide, with loose brush on shore to a 6-foot stage.

Season's work on Missouri shore protection opposite Maple Island was closed on November 16, the proposed length not yet completed. The work done averaged 87 feet in width, with a slope of 3 to 1, brush mat 40 feet wide in water, and loose brush carried up bank to a 6-foot stage. Length of this shore protection is 4,375 feet.

The working season in this section extended from September 17 to November 22, with full Government plant in the field. After departure of towboat *Parke* for winter quarters a small force remained until November 28 finishing up Dams 15 and 20, when balance of fleet was laid up for winter.

Outline sketches and the following table are submitted, showing further details as to character and extent of the work accomplished:

List of works constructed and of materials used during the season of 1894 between Illinois River and Missouri River.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 84:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing Dam 13	1,430	7	5,616	5,481.5
Wing Dam 14	1,150	7	2,417.9	3,668.4
Closing Dam 15	1,454	5	8,205.9	10,727.2
Wing Dam 16	500	7	1,727	3,056.3
Wing Dam 17	700	6	2,753.2	5,393.8
Wing Dam 18	320	6	798.2	1,113.2
Wing Dam 19	550	6	2,483.3	4,306.9
Wing Dam 20	280	6	2,444.5	3,475.6
Shore protection on Piasa Island	2,600	.....	5,767.2	2,753.9
Shore protection Missouri shore, opposite Maple Island	4,375	.....	13,462.2	5,564.8
Total	.....	.....	45,675.4	45,541.6

NOTE.—In addition to the above, there were put in Dam 15, 11,659 linear feet of piles, 1,393 linear feet of stringers, and 45 braces.

Financial statement for work of constructing dams and revetments between Illinois River and Missouri River, performed by hired labor during the season of 1894.

Amount expended in field during calendar year 1894		$54,691.18
Less retained percentage (1893)	$861.05	
Less cost of dredging temporary channel at Hop Hollow	590.49	
Less cost of piles and stringers for pile dam, and labor of placing same	1,124.26	
		2,575.80
Net cost of field work		52,115.38
Add quota of general superintendence and office expenses		1,238.09
Add for use and deterioration of plant		5,888.12
Total		59,241.59
Material put in works:		
Rock	cubic yards	45,675.4
Brush	do	45,541.6
Total		91,217
Average cost per cubic yard:		
On barges		$0.328
For towing and putting in place		.243
For general superintendence and office expenses		.014
For plant		.064
Average cost per cubic yard in place		.649

SURVEY.

A survey was made from the mouth of the Missouri River to the head of Iowa Island. The notes of this survey have since been platted, and the resulting map will be used in preparing a detailed project for the improvement of this reach.

Very respectfully, your obedient servant,

CHARLES KELLER,
Second Lieut., Corps of Engineers.

Maj. A. MACKENZIE,
Corps of Engineers.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON PLANT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 31, 1895.

MAJOR: I have the honor to present the following report on the floating stock or plant belonging to the improvement of the Mississippi River between the mouth of the Missouri River and Minneapolis for the calender year ending December 31, 1894:

In this report "good" is in fine condition, wanting slight repairs or none; "fair" requires extensive repairs, or such as are advisable; "bad" should be condemned or rebuilt. Pieces condemned are omitted.

The plant in question is as follows: One large towboat (*Coal Bluff*), good; 2 medium-sized towboats (*Fury* and *Alert*), good; 1 medium-sized towboat (*Vixen*), bad; 1 small towboat (*Mac*, formerly *Freddie*), good; 6 steam launches (*Lucia, Emily, Ada, Elsie, Iris*, and *Louise*), good; 1 small steam launch (*Florence*), fair; 3 small naphtha launches (*Myra, Dart*, and *Edith*), good; 1 dredge (*Vulcan*), good; 1 dredge (*Phœnix*), fair; 2 dumps, good; 4 dumps, bad; 3 steam-drill boats, good; 1 suction dredge, good; 2 pile drivers, good; 2 pile drivers, fair; 9 large quarter boats, good; 9 small quarter boats, good; 3 small quarter boats, fair; 4 small quarter boats, bad; 2 large office boats, good; 10 small office boats, good; 8 grasshoppers, good; 3 grasshoppers, fair; 1 derrick boat, good; 1 store boat, bad; 1 boathouse, good; 6 large model barges, good; 73 large barges, good; 2 large barges, fair; 6 large barges, bad; 5 small barges, good; 3 small barges, fair; 8 small barges, bad, and a large number of skiffs, loading boats, powder boats, and pontoons in good condition.

During the year, under projects approved May 8 and July 27, 1893, and August 31, 1894, and special authorities of March 9, June 8, August 21, October 1, October 30, November 9, November 13, December 4, December 11, and December 17, 1894, considerable additions and repairs to plant were made.

There were built at the dry dock at Des Moines Rapids Canal 3 large quarter boats, at $1,450 each; 3 barges, at $1,450 each; 1 building boat, $2,950; 2 office boats, at $250 each; and there were rebuilt 6 model barges, at about $1,700 each; 1 quarter boat (new hull), $650, and 1 barge, $950.

There were rebuilt at Fountain City 3 barges, at $750 each.

There were rebuilt at La Crosse 3 barges, at about $1,000 each.

There were purchased 17 barges, at about $800 each.

Considerable repairs were made to towboats *Coal Bluff, Vixen, Fury, Alert*, and *Mac;* to steam launches *Louise* and *Ada;* to drill boats 6 and 103; to quarter boats 22 and 45; to the suction dredge and 10 barges. Nominal repairs were made to many pieces.

The construction and repair work at the dry dock was done under supervision of Mr. M. Meigs, U. S. civil engineer; that at La Crosse and Fountain City under the supervision of Mr. W. A. Thompson, superintendent, and that at Nininger and Stillwater under supervision of Mr. J. D. Du Shane, superintendent.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Maj. A. MACKENZIE,
Corps of Engineers.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1895.

LIEUTENANT: I have the honor to present a brief preliminary report of operations between Missouri River and Minneapolis during the second half of the fiscal year ending June 30, 1895, as collated from reports of assistants in local charge. Full reports are made by calendar years.

Minneapolis to St. Paul.—In local charge of Superintendent J. D. Du Shane. The amount available being insufficient to commence construction of the lock, no work has been done except surveys for location of land required and office work on the plans, maps, and other drawings. Steps are being taken to acquire title to the needed land.

St. Paul to Lake Pepin.—In local charge of Superintendent J. D. Du Shane. Work in construction of dams and shore protection by hired labor and use of Government plant was commenced June 7 and carried on to end of year. Repairs to shore protection at Island 19 were completed and about 1,500 linear feet of new shore protection built. Wing Dams 15, 16, and 17, running from Wisconsin shore below Prescott, were begun.

Amounts of material put in: Rock, 5,722.6 cubic yards; brush, 8,924 cubic yards.

In vicinity of Diamond Bluff a hired dredge worked on gravel bars which were obstructing the channel, from may 28 to June 13, 1895, removing 3,818 cubic yards gravel and small bowlders.

Reeds Landing to Genoa.—In local charge of Superintendent W. A. Thompson. During January and February, 1895, work was carried on by hired labor in vicinity of Homer Chute. Closing dam at Blacksmith Slough, Wing Dams 51 and 52 (all commenced in 1894), were completed, as also 500 linear feet of shore protection at head of Blacksmith Island.

Amounts of material used in above work: Rock, 3,060 cubic yards; brush, 6,610 cubic yards.

During February a channel 1,000 feet long and 2½ feet deep was cut through the bar above head of Coon Slough by means of teams and scrapers. About 9,700 cubic yards of sand was removed.

Early in April dredge *Vulcan* began operations in cutting a channel through bars above head of Coon Slough. She continued on this work, together with widening the cut at Big Bend, until the close of the year. During a part of April and May men with teams and scrapers aided the work.

Construction of dams and shore protections by hired labor and use of Government plant was resumed May 1 and continued to close of year.

There were built in vicinity of Brownsville, Wing Dams 1-9, inclusive, of an aggregate length of 9,315 feet, and Closing Dam 10 at Raft Channel was commenced.

There were put in the above work, approximately, 14,014 cubic yards rock and 55,368 cubic yards brush.

Genoa to Prairie du Chien.—In local charge of Superintendent W. A. Thompson. Operations in construction of dams and shore protections, under contract with Albert Kirchner, were resumed January 7, 1895, and carried on (excepting from February 6 to April 1) to June 29, when the contract was completed. There were built a closing dam from Island 143 to Island 144, a closing dam across slough in Island 144, and shore protection of a total length of 5,122 feet on Islands 143, 144, 145, and 146, all of which work lies between De Soto and Lansing. The closing dams at Ferryville and Capoli sloughs, commenced in 1894, were completed, and repairs were made to closing dam at Iowa Slough, to closing dam at McDonalds Slough, and to shore protection on Islands 126, 127, and 128.

Amounts of material put in place: Rock, 20,010 cubic yards; brush, 16,667.4 cubic yards.

Glenhaven to Dubuque.—In local charge of Superintendent J. C. McElherne. A contract for construction of dams and shore protections has been let to Albert Kirchner, of Fountain City, Wis., and work will be commenced early in July.

Dubuque to Clinton.—In local charge of Superintendent J. C. McElherne. Operations in construction of dams and shore protections, under contract with Jacob Richtman, of Fountain City, Wis., were in progress at beginning of year and were continued, except during March, to May 4, 1895, when the contract was completed. Shore protections above Fulton, on towhead below Island 287, and on Island 281 were built, aggregating in length 2,024 feet. Closing Dams 5, 8, and 9, and Wing Dams 6 and 7 were also constructed.

In work above mentioned there were put in 12,608.3 cubic yards rock and 9,590.7 cubic yards brush.

Rock Island Rapids.—In local charge of Superintendent J. C. McElherne. Work was done by hired labor and use of Government plant. Drill boats 6 and 103 were put at work early in April and were continued to end of year, the former blasting obstruction at Sycamore Chain, the latter at Smiths and Lower chains. The rock broken by these boats amounts to 4,711 solid cubic yards. Dredge *Ajax* began operations April 14 and continued to end of year at Lower Chain, pool above Moline Chain, and dike in Moline Pool. Six thousand two hundred and twenty cubic yards of rock were removed by dredge *Ajax*. Two trailing dams were built in vicinity of Duck Creek Chain, one on the Iowa side, 1,250 feet long, the other on the Illinois side, 2,400 feet long. There were placed in the dams 21,891.3 cubic yards rock and 1,199.7 cubic yards brush. The buoys, having been repaired and repainted, were

reset April 1 to 4, 1895. There are now 27 buoys in the system, all of which were replaced.

Muscatine to New Boston.—In local charge of Assistant Engineer C. W. Durham. Operations in construction of dams and shore protections were begun June 27, 1895. In the closing dam at Illinois Chute 542.3 cubic yards rock and 1,015.2 cubic yards brush were put in place.

Flint Creek to Iowa River.—In local charge of Assistant Engineer C. W. Durham. Final location of proposed levee was made in June, 1895. The required right of way has been staked out and in great part acquired without cost to the United States. Cross-section work is now going on and a contract for the work, under approved specifications, will soon be let.

Keithsburg to Nashville.—In local charge of Mr. M. Meigs, U. S. civil engineer. Dredge *Phœnix* and tender finished the removal of a patch of rock opposite Millers, near head of Des Moines Rapids. About 1,500 cubic yards of broken rock were removed and placed in Pier 5. The *Phœnix* also removed 2,339 cubic yards of gravel, sand, and bowlders from the channel below Keithsburg, widening the same to about 450 feet, with 5 feet depth at low water. U. S. towboat *Vixen* and fleet of barges, in immediate charge of Overseer John R. Carpenter, built a closing dam from Twin Island to the Iowa shore above mouth of Skunk River and protected the shore of Burlington Island opposite the dam. In vicinity of Keithsburg Dam 14 was raised and strengthened, as also the closing dam in Huron Slough.

There were put in place in above-named work 17,573 cubic yards rock and 24,860 cubic yards brush.

Keokuk to Quincy.—In local charge of Mr. M. Meigs, U. S. civil engineer. Under contract with Jacob Richtman, of Fountain City, Wis., the building of dams and shore protections has been carried on at Upper Bludsoes Crossing and in vicinity of Curtis Landing. The work closed on June 20, 1895, the contract being completed. One thousand and forty-six linear feet of dams and 7,147 linear feet of shore protection were constructed.

There were put in place 12,724.7 cubic yards rock and 20,809.3 cubic yards brush.

Dredging Quincy Bay.—In local charge of Mr. M. Meigs, U. S. civil engineer. Under contract with A. J. Whitney, the dredging of channel outside of the pile bulkhead was continued. Four cuts were made to a depth of 6 feet at low water and 2,000 feet long, furnishing a channel about 80 feet wide. Some dredging was done below the bulkhead to make a basin for rafts between bulkhead and bridge.

Total cubic yards material dredged and removed, 32,634.7.

Warsaw to Quincy.—In local charge of Mr. M. Meigs, U. S. civil engineer. In May and June a field party was engaged in definitely locating and staking out the work to be done in raising and strengthening the existing levees. On June 6, 1895, a contract for performing the entire earthwork was let to Casgrain & McDonald, of Chicago, Ill., who commenced operations near Warsaw during the last week of June.

Quincy to Clarksville.—In local charge of Superintendent S. Edwards. Operations in construction of dams and shore protections by hired labor and use of Government plant began April 15, 1895, and were continued to end of fiscal year. In vicinity of Whitneys Bar four wing dams were built, of a total length of 3,265 feet, and shore protection on point opposite Whitneys, on Bay Island, on towhead below Island 451, on Missouri shore below Island 451, at head of Hickory Chute, at head of Island 454, and at head of Whitneys Bar, aggregating in length 11,772 feet. Some repairs were made to shore protection on Illinois shore above Hannibal Bridge and on Turtle Island. There were put in place: Rock, 27,698.6 cubic yards; brush, 36,823.2 cubic yards.

Clarksville to Hamburg.—In local charge of Superintendent S. Edwards. Construction of dams and shore protections, under contract with Jacob Richtman, of Fountain City, Wis., was begun April 9, 1895, and carried on to close of the fiscal year. Shore protection was built on Illinois shore opposite Grimes and McCoys islands, on Island 472, and on Missouri shore in Thomas Chute, aggregating in length 3,905 feet. A trailing dam was run downstream from Tisdales Towhead, 2,000 feet long.

Amounts of material used: Rock, 11,897.4 cubic yards; brush, 17,158.7 cubic yards.

Hamburg to Cap au Gris.—In local charge of Second Lieut. Charles Keller, Corps of Engineers. Work begun on March 11, 1895, in construction of dams and shore protections under formal contract with Jacob Richtman, of Fountain City, Wis., was brought to a close May 21, the contract having been completed. Repairs were made to Dams 2, 4, 5, 14, and 16, and shore protection, aggregating 3,580 feet in length, was built on Missouri shore at Dam 16 and on Islands 489, 490, and 491. There were put in place 30,926 cubic yards rock and 22,021 cubic yards brush.

Cap au Gris to mouth of Illinois River.—In local charge of Second Lieut. Charles Keller, Corps of Engineers. Work resumed May 22, 1895, in construction of dams and shore protections under formal contract with Jacob Richtman, of Fountain City, Wis., was carried on to close of year. At Auers Landing the shore was protected for a length of 856 feet. Closing Dam 9 and Wing Dam 10 were completed, and Wing Dam 11 commenced.

Amounts of materials used: Rock, 14,758 cubic yards; brush, 13,955.1 cubic yards.

Illinois River to Missouri River.—In local charge of Second Lieut. Charles Keller, Corps of Engineers. Construction of dams and shore protections by hired labor and use of Government plant was begun June 13, 1895, and carried on to end of fiscal year. Shore protection on Missouri shore, opposite Maple Island, and at Riverside Park, was built, of a total length of about 2,000 feet.

Amounts of material used: Rock, 9,308.3 cubic yards; brush, 11,204.3 cubic yards.

Surveys.—A continuous detailed survey of the river from head of Crooked Slough to Clayton has been made.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Second Lieut. CHARLES KELLER,
Corps of Engineers.

X 3.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open for navigation two hundred and fifty-one days, during which time there passed through it 606 steamboats and 340 barges, carrying 14,141 passengers, 22,034.5 tons of merchandise, and 55,729 bushels of grain. There also passed through the canal 155,625,800 feet, B. M., of lumber, 29,545,910 feet of logs, 55,670,204 shingles, and 55,064,988 laths.

The expenses of operating and caring for the "Des Moines Rapids Canal and Dry Dock," including dredging and repairs to gates, machinery and plant, have been during the past year $37,882.07. These expenses are provided for by an indefinite appropriation made by act of March 3, 1881.

During the year nominal repairs were made to lock gates and lock machinery and to the canal embankment and guide piers on the rapids. No dredging was done, but a small amount of rock was removed from channel above the guard lock and below lower lock. Dredge *Ajax* and dump boats A and C were rebuilt.

The dry dock was in constant use, and at times when not required for repairs to portions of the Government plant, boats and barges belonging to private parties have been docked and repaired. The dockage fees collected from private parties during the fiscal year amounted to $295.

Abstract of appropriations.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, for fiscal year ending—	
June 30, 1882	45,000.00
June 30, 1883	75,000.00
June 30, 1884	47,000.00
June 30, 1885	40,500.00
June 30, 1886	43,000.00
June 30, 1887	44,000.00
June 30, 1888	42,000.00
June 30, 1889	39,000.00
June 30, 1890	43,837.97
June 30, 1891	43,995.80
June 30, 1892	44,000.00
June 30, 1893	58,000.00
June 30, 1894	56,652.49
June 30, 1895	48,599.05
Total	780,585.31

Money statement.

June 30, 1894, balance on hand	$2,271.68
June 30, 1895, amount drawn from Treasury under indefinite appropriation	41,000.00
	43,271.68
June 30, 1895, amount expended during fiscal year	41,052.80
June 30, 1895, balance on hand	2,218.88

List of vessels docked in the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1895.

Designation.	Date of entering dock.	Date of leaving dock.	Designation.	Date of entering dock.	Date of leaving dock.
	1894.	1894.		1894.	1895.
Flat No. 116	July 3	July 6	Steamer General Barnard	Nov. 16	Mar. 28
New hull for quarter boat No. 45*	July 3	July 6	Steamer Stella	Nov. 16	Mar. 28
Steamer Vixen	July 6	July 9	Steamer Vixen	Nov. 16	May 7
Model barge No. 87	July 9	July 11		1895.	
Model barge No. 89	July 11	July 13	Dredge Phœnix	Mar. 28	Apr. 4
Steamer Mary Morton†	July 18	July 20	Coal flat I	Mar. 28	Apr. 4
Pontoon of dredge No. 14	July 20	July 21	Flat G	Mar. 20	Apr. 4
Dredge Vulcan	July 23	July 23	Flat H	Mar. 28	Apr. 13
Lighter No. 98	July 28	July 31	Steamer Sidney†	Apr. 4	Apr. 5
Steamer J. W. Mills†	July 30	July 31	Lighter No. 98	Apr. 5	June 4
Steamer St. Paul†	Aug. 2	Aug. 5	Steamer Lilly	Apr. 20	Apr. 20
Quarter boat No. 47*		Aug. 2	Barge No. 195 (old hull Vixen)		Apr. 20
Steamer Sidney*	Aug. 6	Aug. 10	Old hull of steamer Stella		Apr. 27
Steamer Louise	Aug. 10	Aug. 11	Flat No. 179*		May 7
Steamer Stella	Aug. 11	Aug. 14	Pile driver No. 104	May 7	May 11
Steamer Lucia	Aug. 14	Aug. 14	Steamer J. G. Parke	May 7	May 11
Flat No 30	Aug. 14	Aug. 17	Steamer Bella Mac†	May 11	May 12
Flat No. 47	Aug. 27	Aug. 30	Quarter boat No. 183*		May 15
Flat No. 111	Aug. 30	Sept. 6	Flat No. 181*		May 21
Canal flat G	Aug. 30	Sept. 30	Flat No. 180*		May 28
Flat No. 144	Aug. 31	Sept. 2	Flat No. 30	May 28	June 4
Flat No. 143	Aug. 31	Sept. 2	Flat No. 63	May 28	(§)
Steamer Coal Bluff	Aug. 31	Sept. 2	Flat No. 76	May 28	(§)
Steamer Vixen	Sept. 5	Sept. 6	Dump No. 2	May 28	(§)
Dump B	Sept. 6	Sept. 8	Dump No. 3	May 12	(§)
Flat No. 93	Sept. 8	Sept. 13	Flat No. 35	June 4	(§)
Flat No. 143	Sept. 8	Sept. 11	Flat No. 41	June 4	(§)
Dredge Phœnix	Sept. 11	Sept. 13	Pile driver No. 58	June 4	June 8
Grasshopper No. 141	Sept. 11	Sept. 15	Grasshopper No. 56*		June 8
Grasshopper No. 142	Sept. 11	Sept. 13	Office boat No. 12*		June 8
Flat No. 52	Sept. 11	Oct. 27	Flat No. 111	June 8	June 12
Quarter boat No. 182	Sept. 13	Sept. 15	Old hull of Stella	June 8	June 12
Flat No. 99	Sept. 13	Sept. 15	Office boat No. 41*		June 14
Steamer Colonel Patterson†	Sept. 29	Sept. 30	Dredge tender A		(§)
Steamer City of Quincy†	Oct. 1	Oct. 2	Dredge tender B		(§)
Building boat No. 64*		Nov. 16	Dry dock flat Jumbo		June 25

* Built in dock. † Belongs to private parties. ‡ Wrecked. § Still in dock.

Table showing the amount of material removed from the Des Moines Rapids Canal from June 30, 1878, to June 30, 1895.

Fiscal year.	Removed by United States dredges.	Removed by teams.	Removed by contract.	Total.
	Cu. yards.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*
1879	8,700			8,700
1880	26,496	1,228	11,553	39,277
1881	9,003			9,003
1882	18,031		49,758	67,789
1883	22,717		90,858	113,575
1884	52,616			52,616
1885	38,097			38,097
1886	65,970			65,970
1887	78,537			78,537
1888	47,333			47,333
1889	86,278			86,278
1890	23,830			23,830
1891	46,751			46,751
1892	149,618			149,618
1893	113,954			113,954
1894	58,025			58,025
Grand total				999,353

In addition to the foregoing there have been removed from head of channel at Montrose during fiscal years ending June 30, 1883, 1884, 1885, and 1895, 16,643, 25,315, 6,007, and 100 cubic yards of material, respectively; total, 48,065 cubic yards.

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1895.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1894.								
July	$375.00	$13.45	$26.80	$415.25	$1,775.00	$204.35	$232.94	$2,212.29
August	375.00	1.95	.....	376.95	1,775.00	218.41	573.82	2,567.23
September	375.00	10.50	48.25	433.75	1,756.34	395.40	1,462.39	3,614.13
October	375.00	8.45	.85	384.30	1,720.00	104.97	1,399.33	3,224.30
November	375.00	67.50	43.23	485.73	1,753.34	198.04	1,184.40	3,135.78
December	500.00	29.50	46.50	576.00	1,312.50	17.20	648.17	1,977.87
1895.								
January	500.00	.....	1.38	501.38	1,312.50	110.79	283.70	1,706.99
February	500.00	.....	40.20	540.20	1,312.50	70.92	222.89	1,606.31
March	500.00	9.55	45.28	554.83	1,312.50	23.41	415.51	1,751.42
April	458.33	.....	28.18	486.51	1,745.00	242.60	455.59	2,443.19
May	375.00	11.83	.....	386.83	1,745.00	169.78	302.35	2,217.13
June	375.00	3.65	34.25	412.90	1,745.00	248.32	531.07	2,524.39
Total	5,083.00	156.38	314.92	5,554.63	19,264.68	2,004.19	7,712.16	28,981.03

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1894.					
July	.....	$3.36	$2,092.28	$2,095.64	$4,723.18
August	.....	.....	469.24	469.24	3,413.42
September	$496.00	60.53	116.11	672.64	4,720.52
October	.....	.....	.....	.....	3,608.60
November	.....	.....	.....	.....	3,621.51
December	.....	.....	.....	.....	2,553.87
1895.					
January	.....	31.53	69.11	100.64	2,309.01
February	.....	8.25	.....	8.25	2,154.76
March	.....	.....	.....	.....	2,306.25
April	.....	.....	.....	.....	2,929.70
May	.....	.....	.....	.....	2,603.96
June	.....	.....	.....	.....	2,937.29
Total	496.00	103.67	2,746.74	3,346.41	37,882.07

Comparative expenditures for operating and care of Des Moines Rapids Canal for the fiscal years 1882–1895.

Year.	Office and administration.				Canals and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1882	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79
1883	4,821.12	289.86	449.52	5,560.50	25,813.40	2,216.87	3,203.01	31,233.28
1884	5,045.22	209.12	665.62	5,519.96	17,654.23	4,344.51	1,291.20	23,289.94
1885	5,015.00	245.31	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77
1886	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86
1887	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62
1888	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,803.05
1889	3,750.00	26.80	318.82	4,095.62	17,241.79	2,277.97	3,689.20	23,208.96
1890	4,425.00	120.84	238.03	4,783.87	18,245.07	2,376.55	7,848.88	28,470.50
1891	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31
1892	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16
1893	5,720.00	137.13	138.73	5,995.86	17,464.67	2,162.64	6,822.35	26,449.66
1894	5,135.00	121.71	711.56	5,968.27	19,585.65	1,707.04	12,974.85	34,267.54
1895	5,083.00	156.38	314.92	5,554.63	19,264.68	2,004.19	7,712.16	28,981.03

Comparative expenditures for operating and care of Des Moines Rapids Canal, etc.—Cont'd.

Year.	Dredging canal.					Miscellaneous.	Grand total.
	Labor.	Supplies.	Repairs.	Contract.	Total.		
1882	$2,340.43	$512.19	$846.58	$14,080.39	$17,839.49	$68.75	$47,053.34
1883	4,765.93	1,583.80	598.04	30,666.17	37,568.94	3,564.07	77,926.79
1884	7,485.45	4,789.32	1,262.02	.....	13,536.79	536.73	43,283.42
1885	3,353.12	8,580.69	1,888.73	.....	13,822.54	.....	44,506.50
1886	4,984.55	3,017.49	3,530.41	.....	11,532.45	.....	43,009.53
1887	6,149.45	3,810.12	2,453.98	.....	12,413.55	.....	42,152.84
1888	5,084.77	2,267.62	1,808.85	.....	9,161.24	1,372.32	42,802.35
1889	5,573.56	3,528.06	2,479.17	.....	11,580.79	.....	38,885.37
1890	3,196.58	1,260.78	6,284.07	.....	10,741.43	.....	43,995.80
1891	3,563.51	1,906.63	702.61	.....	6,172.75	.....	44,998.20
1892	11,333.23	6,370.52	4,259.47	.....	21,963.22	.....	51,550.17
1893	8,712.77	4,481.53	5,464.30	.....	18,658.60	.....	51,104.12
1894	6,719.81	2,227.41	7,716.02	.....	16,663.24	.....	56,899.05
1895	496.00	103.63	2,746.74	.....	3,346.41	.....	37,882.07

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1895.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Laths.	Lockage at one lock.
1894.					*Tons.*	*Bush.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	51	48	56	6,076	1,935	2,588	26,785,072	3,400,000	12,949,954	11,403,565	232
August	20	29	31	1,788	0.5	.....	10,782,442	1,550,000	2,843,500	2,355,900	131
September	26	29	18	.....	300	.....	21,103,977	1,656,000	7,848,430	6,495,400	176
October	34	64	34	70	2,300	.....	33,681,757	1,700,000	12,771,700	9,141.553	216
November	12	18	16	.....	.....	.....	.....	.....	.....	.....	28
1895.											
March	3	....	....	3	225	.....	.....	.....	.....	.....	8
April	14	17	26	1	926	3,500	7,842,350	1,000,000	1,725,250	1,927,300	82
May	46	42	40	181	4,240	20,366	20,383,990	8,709,710	6,375,500	8,094,450	256
June	77	76	119	6,022	12,048	29,275	35,046,212	11,530,200	11,155,870	15,646,770	374
Total.	283	323	340	14,141	22,034.5	55,729	155,625,800	29,545,910	55,670,204	55,064,938	1,503

Comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Lath.	Shingles.	Lockage at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1878	670	548	.....	53,346	737,415	25,000,000	.....	4,000,000	3,700,000	824
1879	802	454	5,038	64,656	2,192,642	33,347,612	8,086,000	8,721,796	11,749,000	1,564
1880	967	651	13,231	78,989	2,197,469	21,832,478	13,160,960	27,863,640	30,651,000	2,497
1881	840	276	10,003	44,962	1,154,092	52,256,235	11,013,410	11,657,655	15,091,000	1,339
1882	760	444	8,588	29,043	781,817	17,150,011	4,475,000	3,112,825	4,885,250	2,292
1883	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	11,558,000	4,435,000	1,353
1884	913	245	13,057	54,215	470,580	57,018,151	9,399,764	15,924,645	25,182,250	1,908
1885	889	169	13,065	54,120	776,432	43,119,797	2,779,670	13,473,205	25,018,750	1,270
1886	784	218	22,221	56,001	465,681	22,769,823	3,195,360	4,302,800	8,253,000	755
1887	990	318	20,797	52,815	366,432	178,754,876	24,827,000	19,961,781	90,450,922	1,717
1888	595	233	8,330	33,160	143,037	166,827,752	34,505,000	83,642,450	49,848,840	1,749
1889	1,022	288	22,880	50,008	381,559	118,508,045	26,333,320	50,221,099	37,413,810	1,941
1890	924	477	14,529	71,453	397,783	146,078,329	26,689,300	44,316,167	73,540,370	1,827
1891	878	357	15,801	45,217	364,878	193,358,089	37,176,150	59,350,595	87,259,690	1,895
1892	577	191	10,260	12,228	63,210	140,654,084	24,514,000	39,476,926	61,141,137	1,233
1893	670	234	10,846	33,318	53,257	80,190,519	16,350,200	29,121,020	28,896,260	1,476
1894	619	312	14,752	43,182	83,650	117,360,783	8,612,000	54,710,727	42,112,415	1,394
1895	606	340	14,141	22,034.5	55,729	155,625,800	29,545,910	55,670,204	55,064,938	1,503

Dates of opening and closing of canal for all years since its opening to navigation.

Year.	Canal opened.	Canal closed.	River opened.	River closed.	Highest water.		Lowest water.	
						Feet.		*Feet.*
1877	Aug. 22	Dec. 10	Feb. 17	Dec. 10	.....	20.55	Sept	0.65
1878	Mar. 8	Nov. 28	Open ...	Dec. 20	June 11	12.05	Sept. 22	1.45
1879	Mar. 17	Dec. 9	Mar. 6	Dec. 26	June 2	8.45	Oct. 4	1
1880	Mar. 8	Nov. 19	Jan. 5	Dec. 8	June 29	17.50	Aug. 24	2.05
1881	Apr. 16	Oct. 17	Mar. 25	No close	Oct. 29	18.95	Aug. 29	2.75
1882	May 6	Nov. 25	Open ...	Dec. 15	Apr. 25	15.90	Oct. 5	2.65
1883	Apr. 13	Dec. 6	Mar. 1	Dec. 27	May 8	15.45	Sept. 22	2.10
1884	Apr. 1	Nov. 23	Mar. 15	Dec. 30	Mar. 13	16.80	Aug. 25	2.80
1885	Apr. 1	Nov. 24	Mar. 11	Dec. 14	Mar. 15	12.80	Nov. 30	3.40
1886	Apr. 1	Nov. 21	Mar. 15	Dec. 2	May 6	15.95	Dec. 1	.50
1887	Mar. 28	Nov. 23	Feb. 11	Dec. 21	Feb. 12	11.60	Nov. 28	0
1888	Mar. 29	Nov. 22	Mar. 1	No close	May 16	19.65	Dec. 26	— .80
1889	Mar. 18	Nov. 23	Mar. 3	Feb. 24	Feb. 26	10.75	Dec. 5	— .70
1890	Apr. 1	Nov. 20	Jan. 28	Jan. 21	June 30	12.60	Jan. 3	—2.40
1891	Apr. 1	Nov. 21	Open ...	No close	Mar. 29	10.80	Nov. 30	—1.60
1892	Apr. 1	Nov. 23	Feb. 2	Dec. 23	June 30	19.25	Dec. 18	— .80
1893	Apr. 1	Nov. 15	Mar. 10	Dec. 4	May 15	14.85	Nov. 20	— .95
1894	Mar. 21	Nov. 21	Mar. 1	Dec. 30	June 3	11.35	Dec. 4	— .90
1895	Mar. 15	.....	Feb. 26	.....	Mar. 4	5.10	.....	.....

REPORT OF M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1895.

LIEUTENANT: I have the honor to submit the following report on "operating and care of Des Moines Rapids Canal and Dry Dock" for the fiscal year ending June 30, 1895:

The canal was closed November 21, 1894, and opened March 15, 1895. It was open for navigation two hundred and fifty-one days and closed one hundred and fourteen days. A few boats were locked through after the regular closing of the canal, and one boat passed through on the 23d of December—a very unusual thing. During the past year a very great drought has prevailed, the highest stage—which was reached on March 1, 1895—being 5.1 feet above low water on the lower-lock gauge. The lowest stage prevailed in July and August, 1894, reaching —0.7 foot on the lower-lock gauge, August 31, or, correcting this for the effect of the lower-lock boom, —0.4 foot below low water of 1864. On the same date the stage of water at Mechanics Rock, above the canal, was 43 inches below its top, or —0.33 foot. As a consequence of the low water, business on the river declined, boats were laid up, and stagnation prevailed, to which the business depression of the country greatly added. Some few raft boats continued to make trips, however, and there were a good many excursion boats through the canal, but the traffic statement does not compare well with some previous years.

Repairs to gates, machinery, and buildings.—On March 22, 1894, the water was drawn off from the canal and the usual examinations were made. New chains were put in for opening the upper gates at lower lock, and some leaks in the hydraulic pipes, across the breast wall, were stopped with clamps. Hydraulic cylinder at lower lock was repaired.

In April and May leaks occurred in the pipes supplying the gate cylinders of the lower outside gate at lower lock. Some of these pipes were dug up and clamps applied to the leaky spots. The pipes have been buried eighteen years, and, though in good condition mostly, have suffered from pitting, which will eventually require their removal.

The machine shop at the lower lock was painted with two coats of paint; also all the iron roofs of the lower lock and dry dock buildings. The old storehouse and coal shed at the lower lock were reshingled. Repairs were made to the throttle of the middle-lock engine, and the dynamo at the lower lock was rewound with new wire, the old wire having burned out from long usage. A small electric engine was built and set up at the machine shop and a fire pump of the Worthington make put in for fire protection in the wintertime, when the lock pumps are out of service.

Repairing the canal embankment.—In September, 1894, a large leak was discovered in section 1, just above the lower lock. The bank caved in, and repairs became imperative. The bank at the leak was dug down to the level of the water in the canal, and about 50 linear feet of sheet piling were driven. A large amount of rock was found in the center of the bank and removed, being used to strengthen the guide piers on the rapids above the canal. A small amount of work was done in repairing a leak at section 19 and refilling the cavity found there.

Repairs to guide piers.—Guide piers 1 and 2 were sheathed and painted. Pier No. 3, moved by the ice, was replaced and refilled with rock. Pier No. 4 was rebuilt complete with spare timbers from the dry dock. A new pier, No. 5, was built out of the stone excavated opposite Millers Run. All the piers were painted and numbered, and stone from Millers Run excavation was used to strengthen them.

Dredging canal.—In September and October, 1894, a small derrick boat was fitted up and put at work below the lower lock removing bowlders and stray stones that had been pushed into the channel by the ice. Some of them had only 2 feet of water on them at low water, and were lifted with difficulty. September 7 to 10 the towboat *Vixen* and dredge *Phœnix* assisted at this work, and took out some large pieces of ledge rock under the drawspan of the bridge at Keokuk too heavy for the derrick boat to handle. A quantity of loose stone was also taken out above the guard lock, opposite and above Dynamite Island. The total amount excavated was small, though the importance of the work was great. I estimate the whole amount removed to be 100 cubic yards.

Repairs to plant.—The canal dredge *Ajax* was rebuilt completely, with a new hull built of Oregon fir; her boiler was fitted with new flues and a new fire box and put in complete repair. This boat was let out of dock July 11 and finished July 20, leaving for Rock Island, Ill., the same day. Dump boats A and C had repairs completed, having been rebuilt from the bottom up. Launch *Lucia* was docked for a few hours and minor repairs made. Her main shaft broke April 11, and was replaced with a heavier one.

Machine shop at lower lock.—During the year the machine shop has been in constant use, especially during the winter months. A pair of engines, 7 by 48 inches, were built for the new dredge tender; also two electric engines and two dynamos. The cylinders of the engines on the *Vixen* and *Stella* were bored out and new piston packing made. A new dipper was built for the *Vulcan*. A large amount of miscellaneous repairs were also made to dredges, snag boats, pile drivers, etc.

Operating dry dock.—The dry dock has been in constant use during the whole year past. Quite a number of private boats made use of it, and for the repairing and building of Government boats it has been of great value. A new planer was purchased and set up in June, 1895, and a boring machine added to the dry dock equipment, both of these machines being much needed. The following partial list shows work accomplished:

Built.—Three barges (5 by 24 by 110 feet, Nos. 179, 180, and 181), 2 office boats (Nos. 12 and 41), 1 building boat (No. 64), 1 grasshopper (No. 56), 1 quarter boat (100 by 20 feet, No. 183), 1 barge (for use at dry dock, built of old material), 1 quarter boat (80 by 20 feet, No. 47).

Rebuilt.—One barge (5 by 20 by 105 feet, No. 98), 1 launch (*Stella*), 2 dump boats (A and C), 1 barge (G, 40 by 10 feet), 1 quarter boat (No. 45).

Commenced.—Two dredge tenders (A and B, 75 by 17 feet).

Repaired.—Twenty-two barges, 1 dump boat, 4 steamboats, 2 pile drivers, 2 grasshoppers, 1 dredge.

During the past year I have been assisted by Mr. John R. Carpenter, acting superintendent, and Mr. O. S. Willey, clerk, who have performed their duties well and faithfully.

Very respectfully, your obedient servant,

M. MEIGS, *U. S. Civil Engineer.*

Lieut. CHARLES KELLER,
Corps of Engineers.

X 4.

OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS.

This improvement, consisting of a lock and dam in the Galena River, was purchased by the United States in March, 1894, under provisions of act of Congress of September 19, 1890, at a cost of $100,000.

Lieutenant-Colonel Mackenzie's project of July 8, 1894, approved July 18, called for an allotment of $3,000 for operating and care of the lock and dam and for dredging in Harris Slough. On December 20, 1894, Colonel Mackenzie presented an additional project, which was approved December 29. This project recommended an allotment of $3,000 for repairs to the lock, the floor and miter sills of which were in bad condition.

In October, 1894, by means of a hired hydraulic dredge, a channel 40 feet wide and 4 feet deep was cut through the bar at the mouth of Harris Slough, and further dredging was done in various parts of the slough. Between November 19, 1894, and February 6, 1895, extensive repairs were made to the floor and other parts of the lock. In May and June, 1895, a survey of the entire improvement was made with reference to preparing estimates for the coming year.

During the past year the lock was open for navigation from July 1 to November 10, 1894, and from March 26 to June 30, 1895, a period of two hundred and thirty days, during which time there passed through 471 steamboats and barges, carrying 4,798 passengers and 1,939 tons of merchandise. Three hundred and twenty lockages were made. The expenses of the fiscal year ending June 30, 1895, were $6,000.

Abstract of appropriations.

By act approved—	
September 19, 1890	$100,000.00
July 5, 1894, for fiscal year ending—	
June 30, 1894	1,500.00
June 30, 1895	5,135.68
Total	106,635.68

Money statement.

June 30, 1895, amount drawn from Treasury under indefinite appropriation	$6,000.00
June 30, 1895, amount expended during fiscal year	6,000.00

Expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1895.

Month.	Superintendence and office expenses.	Operating.		Repairs to lock.	Dredging.	Total.
		Labor.	Supplies.			
1894.						
July		$194.00				$194.00
August	$9.25	179.00	$3.83			192.08
September		170.00				170.00
October	31.88	170.00			$900.00	1,101.88
November		170.00		$257.24		427.24
December	22.18	170.00		855.50		1,047.68
1895.						
January	34.56	170.00	27.81	1,558.41		1,790.78
February	6.04	170.00		120.56		296.60
March		170.00	1.55			171.55
April		185.00				185.00
May	14.38	225.50	10.44			250.32
June	2.87	170.00				172.87
Total	121.16	2,143.50	43.63	2,791.71	900.00	6,000.00

X 5.

MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND ST. PAUL—CONSTRUCTION OF LOCK AND DAM No. 2.

The river and harbor act of August 17, 1894, contained the following:

Improving the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge at St. Paul, and the Washington Avenue Bridge at Minneapolis, fifty-one thousand dollars, which, together with the unexpended balance standing to the credit of this improvement, shall be expended under the project or

plan to extend navigation from St. Paul to the flour mills at Minneapolis, estimated for by Major Mackenzie as appears by his report made to General Thomas L. Casey, Chief of Engineers, U. S. Army, under date of March 1, 1894, by the construction of Lock and Dam numbered two in the same project.

The unexpended balance referred to was $49,877.67. The estimate for Lock and Dam No. 2 is $598,235, and the cost of the lock foundation, excluding purchase of land, is given at $125,000. During the year surveys were made for locating Lock and Dam No. 2, and steps were taken for acquiring the needed land. The money available being insufficient to build the lock foundation, no construction work was performed.

Abstract of appropriations.

By act approved—	
August 17, 1894	$51,000.00
July 13, 1892 (allotted by act of August 17, 1894)	49,877.67
Total	100,877.67

Money statement.

Amount appropriated by river and harbor act of July 13, 1892 (allotment)	$49,877.67	
Amount appropriated by river and harbor act of August 17, 1894	51,000.00	
	100.877.67	
June 30, 1895, amount expended during fiscal year	2,441.04	
July 1, 1895, balance available	98,436 63	
Amount (estimated) required for completion of existing project	499,798.37	
Amount that can be profitably expended in fiscal year ending June 30, 1897	499,798.37	
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

X 6.

PRELIMINARY EXAMINATION OF QUINCY BAY, ILLINOIS.

[Printed in House Ex. Doc. No. 52, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report of October 26, 1894, by Maj. A. Mackenzie, Corps of Engineers, giving results of preliminary examination of Quincy Bay, Illinois, required by river and harbor act of August 17, 1894.

From the facts and reasons given, Major Mackenzie reports that it is evident that Quincy Bay is worthy of improvement by the General Government, and this conclusion is concurred in by the division engineer, Col. O. M. Poe, Corps of Engineers, and by this office.

The necessary surveys to furnish data for future work can be made with funds available.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill, October 26, 1894.

GENERAL: The river and harbor act of August 17, 1894, provides for a preliminary examination of Quincy Bay, Illinois. This examination was assigned to me by letter of the Chief of Engineers, dated August 20, 1894.

Congress has appropriated for improvement of Quincy Bay, and work has been carried on at intervals during the last fifteen years.

The river and harbor act of June 18, 1878, provided for a survey of Quincy Harbor. Maj. F. U. Farquhar, Corps of Engineers, in his report of January 13, 1879, considering the bay as part of the harbor, says:

> The width of the bay varies from 200 to 700 feet, and the depth of water, at lowest stage, from 2 to more than 20 feet. * * * In years gone by, before the lower end of the bay filled up, it was used as a winter harbor for steamboats; but the area of water over 4½ feet deep at lowest stage (which generally occurs in winter) is so small that the harbor is not now used at all. It will be seen that the sand and gravel brought down by a small stream from the bluffs have formed a large part of the filling up of the bay.
>
> To improve this bay for use as a winter harbor and to accommodate commerce it is proposed to dredge to a depth of 6 feet at low water, * * * an area of about 90 acres (shown on map). The total amount of material to be dredged amounts to 680,000 cubic yards, which, at 25 cents per cubic yard, will cost $170,000. * * * It is supposed that the improvement of the harbor will furnish a much-needed winter harbor for vessels, and will increase the commerce and manufactures of Quincy.

In accordance with project above indicated, appropriations and allotments for dredging in Quincy Bay have been made as follows:

Act of—	
March 3, 1879, allotment	$10,000
June 14, 1880, allotment	10,000
March 3, 1881	10,000
August 2, 1882	15,000
July 5, 1884, allotment	12,500
Total	57,500

Operations under these appropriations resulted in the removal of 287,529 cubic yards of material, the dredging being carried on over an area of about 54 acres, which, with the deep water areas, made altogether 82 acres of available harbor. A large portion of this area has required dredging several times, owing to deposits, caused chiefly by Whipple Creek.

On March 20, 1890, a board of engineer officers established harbor lines in Quincy Bay and made a report, from which extracts are given below:

> Quincy Bay, an arm of the Mississippi River, forms a portion of the harbor of Quincy, Ill., and its shores are made use of as sites for sawmills, ice houses, manufactories, and railroad yards. The bay is used as a safe harbor for boats, especially during the winter.
>
> Congress, appreciating the advantages of Quincy Bay as a winter harbor for boats and barges, has from time to time appropriated money for its improvement, and $57,500 have already been expended by the Government for dredging and increasing the depth and available water area.
>
> Notwithstanding the natural advantages offered by Quincy Bay, and the improvements carried out by the Government, its use has been, and now is, restricted by the private ownership of nearly all the property surrounding the bay, and the shores are not available for tying up of boats and barges belonging to the general public.
>
> For many years the owners of land adjoining the bay have been filling out and encroaching upon the water area, and by the dumping of refuse from the shores and boats, and from other causes, the natural depth of the bay has been and is constantly

being reduced. While the encroachment on the bay apparently has not yet been so great as to destroy its usefulness as a winter harbor, any further uncontrolled reduction of area might do so.

The city of Quincy, through its officers, has made some effort to control and protect the bay and the interests of the navigators using it, but apparently without full success, and the city now asks that harbor lines be established around the bay by the Secretary of War, under the provisions of section 12, river and harbor act of August 11, 1888.

A survey of Quincy Bay has been made under the direction of Major Ruffner, Corps of Engineers, and many of the old survey marks and meander lines were found. The original patents and titles to land bordering on the bay have also been as thoroughly examined by Major Ruffner as the records available permit. It appears from these surveys and examinations that the meander lines of the Government survey of the portion of Quincy Bay under consideration follow the original shore lines of the bay, and that the patents do not grant title to the land lying under the waters of the bay. It also appears that on the east side of Quincy Bay, owing to filling, the present shore line is in all cases in front or on the water side of the original meander lines. On the west or island side of the bay, where there has been little or no filling, the meander lines of original survey are in places slightly in front of present shore line.

From consultations with the representatives of the city of Quincy, it appears that it is the desire of the city that the Secretary of War, acting under authority which the city authorities believe to be conferred by section 12, river and harbor act of August 11, 1888, should declare the original shore line, rather than the present shore line, to be the harbor line of Quincy Bay. It appears to be the opinion of the city representatives that such a fixing of lines would assist the city in obtaing possession of the made land bordering on the bay and, with such possession, the fuller control of the bay itself.

The board is of the opinion that the securing by the city of the control of the shores of Quincy Bay is most desirable, in fact a necessity, for the proper protection of the interests of navigation, and they also consider it a matter of regret that the original area of Quincy Bay has been so materially reduced by the artificial and undoubtedly authorized filling out of the east shore.

But it appears to the Board that, notwithstanding the filling up of a portion of the bay, there still remains a sufficient water area for the use of the general public as a winter harbor, and they, therefore, do not consider it necessary or desirable to provide for the enlargement of the present water area of the bay by the establishment of harbor lines behind or on the land side of the present shore lines, thereby possibly involving the United States in the complicated question of shore and property rights and ownership.

It being practicable to further slightly reduce the area of the bay without materially interfering with its use as a winter harbor or for other legitimate purposes, it has seemed proper, in fixing upon boundaries of the bay, to take into consideration the future probable desire of the city of Quincy or others legally authorized to straighten and improve the frontage on the bay by building out to regular lines.

* * * * * * *

It is recomended that, when the same may be practicable, the lines adopted be marked by groups of piles at turning points and at intervals of about 500 feet, such piles being so driven as not to interfere with any existing shore lines.

The harbor lines were marked by groups of piles, three in a cluster, and placed about 500 feet apart on each side of the harbor.

The act of September 19, 1890, alloted $25,000 for dredging in Quincy Bay, but of this amount the sum of $11,987.55 was reserved and subsequently, by act of July 13, 1892, made available for construction of a retaining levee on Whipple Creek Bar. Dredging under allotment, made by act of September 19, 1890, consisted in the removal of 82,964 cubic yards of material, and the bay at close of season of 1891 was in good condition, there being ample depth for all purposes of navigation, and also a deep, though narrow, channel through Whipple Creek Bar.

In 1892 and 1893 the retaining levee or pile bulkhead at Whipple Creek Bar was constructed, and 18,061 cubic yards of material was dredged and removed.

There has been expended to date on improvement of Quincy Bay the sum of $82,500, and the river and harbor act of August 17, 1894, allots an additional sum of $15,000 for dredging the channel at Quincy Bay.

In view of the foregoing it appears evident that Quincy Bay is worthy of improvement by the General Government. The necessary surveys of the bay, to show results of past work and furnish data for future work, can be made with funds available, and no further allotment will be required.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 29, 1894.

Respectfully forwarded to the office of the Chief of Engineers. I concur in the conclusions of the district engineer, as herein expressed.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

X 7.

PRELIMINARY EXAMINATION OF LA CROSSE HARBOR, WISCONSIN.

[Printed in House Ex. Doc. No. 78, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report of September 21, 1894, by Maj. A. Mackenzie, Corps of Engineers, of the results of a preliminary examination of La Crosse Harbor, Wisconsin, for removal and prevention of bar, made to comply with provisions of the river and harbor act of August 17, 1894.

Major Mackenzie is of opinion that this harbor is worthy of improvement by the General Government, if such improvement can be given at a cost commensurate with the interests involved. This opinion is concurred in by the division engineer, Col. O. M. Poe, Corps of Engineers, and by this office.

It is estimated that the survey necessary for preparation of plan and estimate for improvement will cost $500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., September 21, 1894.

GENERAL: The river and harbor act of August 17, 1894, provides for a preliminary examination of "La Crosse Harbor, Wisconsin, for removal and prevention of bar." This examination was assigned to me by letter of the Chief of Engineers, dated August 20, 1894.

A knowledge of the locality and information obtained from a survey made in 1892 enable me to report that La Crosse Harbor is worthy of improvement by the General Government, if such improvement can be given at a cost commensurate with the interests involved.

La Crosse is a city of about 30,000 inhabitants, and with many large factories, sawmills, machine shops, foundries, etc., and an extensive boat yard. It is headquarters for many of the steamboats employed in the immense lumber trade of the Upper Mississippi River. All boats stop there for supplies, mail, or other reasons. A further reduction of its landing by encroaching sand and mud thrown out by the La Crosse River would be a positive injury not only to the city itself, but very probably to the interests of navigation.

Secondly. Without fully conceding the advisability of improvement, I would recommend a survey for the purpose of determining whether the cost of improvement would be too large to justify it. The cost of such survey, with maps, report, and estimate, would be about $500.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[Second indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., September 28, 1894.

Respectfully forwarded to the Office of the Chief of Engineers, approved.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

X 8.

SURVEY OF EAST BANK OF MISSISSIPPI RIVER FROM THE CITY OF WARSAW TO THE CITY OF QUINCY, ILLINOIS.

[Printed in House Ex. Doc. No. 111, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C. December 11, 1894.

SIR: By the provisions of the river and harbor act of August 17, 1894 the Secretary of War is directed to cause a survey to be made along the east bank of the Mississippi River from the city of Warsaw to the city of Quincy, with a view to improving the navigation by preventing

the water from overflowing the natural and artificial banks along that part of the river and deepening the channel.

The duty of making this survey was assigned to Maj. A. Mackenzie, Corps of Engineers, and I have now the honor to submit herewith his report of December 8, 1894, with map,* of the results of the survey provided for. Maj. Mackenzie estimates the cost of constructing the proposed levees at $85,500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 8, 1894.

GENERAL: The river and harbor act of August 17, 1894, contains the following item:

> And out of said appropriations he (the Secretary of War) shall cause a survey to be made * * * along the east bank of the Mississippi River from the city of Warsaw to the city of Quincy, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel.

By letter of the Chief of Engineers, dated August 20, 1894, this survey was assigned to me. A small party was put in the field September 27, 1894, and completed its field work October 17. The maps of the Mississippi River Commission, lately published, covering this portion of the river, are so complete in their topographical features that but little field work was needed, except a line of levels to ascertain elevations of crown and base of existing artificial banks.

The first of these levees or artificial banks extends from Warsaw to the county line of Hancock and Adams counties. This levee is 11¾ miles long, was built in 1881, and is called the Hunt Levee. The second levee, which was built in 1888, is called the Lima Lake Levee, and extends from the lower end of the Hunt Levee to the bluffs at the outlet of Bear creek, 10½ miles. The third levee, completing the system, is called the Indian Grave Levee, and was built in 1881; this levee extends from Bear Creek to Quincy, 17 miles, making in all about 39 miles of artificial bank, topping the natural bank, and restraining the river from overflow throughout the entire distance from Warsaw to Quincy.

The artificial banks above mentioned were built with scrapers, of earth obtained in the immediate vicinity, which appears to be a very fair material for the purpose; they were constructed under the drainage laws of Illinois and paid for by direct tax on the lands benefited. The normal slope is two to one on the inside and three to one on the outside, where more exposed to action of waves, the crown being about 4 feet in width. The average height is about 7 feet. There is a berm on both sides averaging 20 feet in width between the foot of the slopes and the borrow pits. The right of way extends 100 feet on both sides of the levee, so that in the event of raising and strengthening the same sufficient material could be obtained in the immediate vicinity without expense other than for labor.

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*Omitted. Printed in House Ex. Doc. No. 111, Fifty-third Congress, third session.

The artificial banks above described have withstood the ordinary high waters reasonably well, but a great amount of damage was done by the floods of 1881, 1888, and 1892. The flood line in this section of river appears to have been somewhat raised by present contraction, and may be further elevated when the levees on the west side, now in course of construction, are completed. It would be well, then, in presenting a project for reenforcing and making these artificial banks secure, to raise their crown to a grade of 3 feet above high water of 1892, and the estimate contemplates such a grade.

There will be needed to raise and strengthen the banks in the Hunt district 241,989 cubic yards of earthwork, in the Lima Lake district 67,286 cubic yards, and in the Indian Grave district 293,368 cubic yards; total, 602,643 cubic yards.

About 2 miles of the more exposed portions of the bank require a revetment about 6 feet in width.

ESTIMATE.

602,643 cubic yards earthwork, at 12½ cents	$75,330.38
1,200 cubic yards riprap, at $2	2,400.00
Engineering, contingencies, etc., about 10 per cent	7,769.62
Total	85,500.00

I inclose the report of Mr. M. Meigs, United States civil engineer, giving details and a map of the survey.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, December 4, 1894.

MAJOR: In accordance with your instructions I have the honor to submit the following report on a survey of the existing levees between Warsaw and Quincy, Ill., "with a view to improving the navigation of the Mississippi River by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel," as expressed in the river and harbor act of August 17, 1894. This report contains an estimate of cost of so raising and strengthening the levees, which are continuous from Warsaw to Quincy, as to put them out of danger from floods, and a map showing detailed information accompanies.

Levee districts.—The levees between Warsaw and Quincy were built under the Illinois law applying to drainage districts and were paid for by direct tax on the lands supposed to be benefited. The first levee built was called the Hunt Levee, and runs from high ground at Warsaw to the line of Hancock and Adams counties, 11¼ miles. The construction of the Hunt Levee was begun in January, 1881, and it was completed to the county line in September. In the latter month very high water occurred and the levee was in many places completely submerged, and also suffered numerous breaks. After the subsidence of the water the breaks were repaired, and at localities where actual high water showed its elevation to be insufficient the levee was considerably raised. At this time the lower end of the levee was not connected with high ground, and at succeeding high waters the floods backed in over the land at the lower end of the district and no benefit from the levee was received except by the farms at the upper end in the vicinity of Warsaw. On account of the above disastrous condition of affairs it was found necessary to extend the levee system, and accordingly in 1888 a second levee was built, called the Lima Lake Levee, lying wholly in Adams County and extending from the county line where the Hunt Levee ends to the bluffs at the outlet of Bear Creek, a distance of 10¼ miles. A third levee, called the Indian Grave Levee, was built in 1881, contemporaneously with the

Hunt Levee, and extends from Bear Creek to Quincy, 17 miles. This levee was not connected with the bluff at the lower end until 1888. The three levees mentioned make a complete levee system from Warsaw to Quincy.

Commissioners.—There are three levee commissioners for each levee district, nine in all, who have charge of the finances, repairs, etc. Under this management there is but little concert of action, and as the interests of the commissioners at the upper end often clash with those of the commissioners at the other end there has resulted at times of danger from flood a lamentable lack of harmony in their efforts to prevent disaster.

High-water notes.—In October, 1881 (stage at Keokuk 19.95 feet above low water), the Hunt and Indian Grave levees were overtopped by the floods and many breaks occurred. In 1882, 1883, 1884, 1885, 1886, and 1887 (stages 15.45 to 11) the levees withstood the floods admirably. In May, 1888 (stage 19.65), numerous crevasses occurred and the levee districts were flooded. In 1889, 1890, and 1891 there was no very high water and the levees held. In June, 1892 (stage 19.25), a crevasse occurred at station 542 and water poured over the levee in places for one-half mile in length and 6 inches deep. The damage was small, except to the crops in the Hunt and Lima Lake districts, which were destroyed. In the Indian Grave district there was no crevasse, but seep water and rain water prevented the raising of a crop. In May, 1893 (stage 14.85), the levees held, but each district suffered from seep water and backwater on account of the long duration of the flood. In 1894 no very high water occurred.

It will be seen from the above that the levees as now existing and managed have in fact withstood the floods for several years with but few breaks, and those insignificant in amount. That at station 542 in 1892 was never over 150 feet wide and from 6 to 7 feet deep, and could have had but little effect upon the vast volume of water flowing in the main river.

Danger line.—The safe grade to be given the crown of the levee to prevent overtopping by the floods is a matter of some complexity, as the conditions in and along the river are constantly changing. In the diagram given on the map herewith the high-water slope of the river is platted on a small longitudinal scale in order to present certain features. The high water of 1888 and 1892 are compared and a manifest elevation of the flood line of about 2 feet is shown—doubtless due to levee construction. It is probable that the extension of levees will still further raise the flood line in the near future. As shown on the map, two levees just built now exist, one on the right bank of the Des Moines River and one extending along the right bank of Fox River and thence down the Mississippi to a point about 1¼ miles below Gregorys Landing. No high-water determination since 1892 has been possible, but the parts of the levees on the Illinois side overflowed in 1892 will doubtless, if not raised, be overflowed to a greater extent as a consequence of the next extreme flood.

The survey shows that the present grade of the levees is not high enough for safety. In some cases the want of elevation is due to imperfect construction and erroneous levels; in others to the wear consequent on the use of the levee as a wagon road, and also to the haphazard methods followed by the commissioners in making repairs. It is therefore quite evident that, although the levees are high enough as far as the interests of navigation are concerned, if the Government desires to undertake their preservation and that of the crops back of them they must be raised to a safe height.

On the assumption that the Government desires to know what such work will cost estimates are given. The grade line assumed as safe is 3 feet above high water of 1892. This high water is well marked by the wash on the levee itself and by many evidences collected from settlers along the river—on their houses when outside the levee and on trees.

The levees.—These are of the usual construction, built with scrapers from shallow borrow pits. There is a berm 20 feet wide at the bottom of the slopes, and the pits are both outside and inside the levees. Repair work, chiefly performed at periods of high water, was necessarily done from the inside. The levee commissioners control 100 feet of land each side of the levee, so that any future work can be executed without expense except for labor, providing the present pits are used. It is of course undesirable to deepen these pits; but it is thought sufficient earth to make the additions contemplated can readily be obtained without going outside the 100-foot limit. The normal sections of the levee are shown on the map as well as the proposed additions. The levee material is the usual alluvial soil found adjacent. In some places it is quite sandy and liable to abrasion under the action of waves. In the timbered country it is quite light and porous, but makes, however, a good levee when put up by scrapers, and especially when consolidated by use as a wagon road. The resistance of this material to abrasion can be judged when it is stated that the river has topped the levee by 6 inches for distances of one-half mile and caused no break and but little wash. The levees are entirely overgrown with weeds and grass and are well consolidated.

In the Hunt Levee cracks are noticed extending down into the levee parallel with its axis, no doubt caused by the shrinking of the fresh earth added after the high water of 1881. Such cracks should be plowed and carefully refilled. The average height of the levees is about 7 feet; the normal profile 3 to 1 on the outside and 2 to 1 on the inside. All reenforcement it is proposed to apply to the inside of the bank, as the old levee is so well consolidated it is much better fitted to withstand the action of water than any new bank could be. The growth of grass and weeds also forms a valuable protection and can not be quickly replaced.

Country back of the levees.—The large bottom land protected by the levees extends nearly 40 miles along the Illinois bank of the Mississippi River from Warsaw to Quincy. It varies somewhat in width, being in its widest parts about 5½ miles wide, opposite Canton and La Grange. Several small streams of no great drainage area enter the bottom from the bluffs and one important creek, called Bear Creek. This stream rises some 50 miles back in Illinois and after heavy rains pours a large volume of water into the Mississippi River. I am told that it has sometimes overflowed the present levees, which are insufficient to completely restrain it. The bottom land in the vicinity is much cut up by a network of sloughs and ponds which formerly held a portion of the water of Bear Creek, but which, since the construction of the levees on both sides of the creek, are now nearly dry. Lima Lake was formerly a sheet of water 6 miles by 2½ miles in extent and was the sump for all the drainage above Bear Creek. At a 12-foot stage in the river this lake had a depth of about 4 feet, due to backwater. Its bed lies, therefore, at an elevation of about 8 feet above low water. It has recently been effectively drained and ditched and is now largely under cultivation or used for a grazing ground for hundreds of cattle. It is probably the richest land in the entire bottom, the fertility of which is wonderful in all parts.

The survey.—The excellent published maps of the Mississippi River Commission rendered a special survey of the levee unnecessary except to collect data of elevation. A small party in charge of Mr. R. Monroe was put in the field September 27, 1894, to run a line of levels the entire length of the levees and take the elevation of ground at the crown and the base. The field work was completed October 17, and since that time two men have been employed in the office working up the data obtained. The map and profiles show nearly all of the information gathered. Measurements taken from the base of the levee to the borrow pits show an average width of berm of 20 feet.

It was thought best to give the bluff lines on the map on both sides of the river, so as to show the extent of the country affected, as well as the contraction in the waterway caused by levee construction. It is to be borne in mind that the west side of the river is as yet only partially defended by levees, and was not at all so when the high water of 1892 occurred.

Outlets.—The drainage water of each of the levee districts is provided for by culverts of boiler steel fitted with cast iron back pressure valves or gates on the river side of the bank. One of these culverts is located where the levee crosses Quincy Bay and the other at Big Slough, opposite Canton. At Quincy Bay there is a pumping station provided with two steam boilers and two large pumps to discharge the drainage of the district when the river is too high to allow it to pass out by gravitation. I could not, however, learn of their ever having been used, and appearances indicate that they have been abandoned. At the Lima Lake (Big Slough) outlet there is talk of building a drainage plant for the same purpose, to be operated by steam, but nothing has as yet been done. If the Government undertakes to improve and care for these levees, it will doubtless be called upon to provide and keep up these pumping stations. I think the present equipment of outlets probably sufficient for the proper drainage of the land, and therefore make no estimate for additional waterway.

Wave protection.—Some parts of the levee are greatly exposed to storm waves, which in times of flood often reach large proportions when urged by a westerly wind, and are liable to do great damage. Such portions of the bank should be revetted. My estimate for, say, 2 miles of such bank, protected for about 6 feet in width, is 1,200 cubic yards riprap rock, which would cost in place about $2 per yard.

Estimate of quantity and cost.—The table given on the map shows by mile sections the quantities of earth required to raise the embankment to the grade of 3 feet above high water of 1892. In addition to the earthwork some expense will be necessary to clear the inside slope of the levee from logs, weeds, etc., and plowing the same prior to the addition of fresh earth. The cracks in the crown of the levee will also have to be filled. Earthwork, such as this reenforcement would call for, can be done at the present time at 10 cents per cubic yard, measured in the embankment; but I have put the cost at 12½ cents to cover clearing of slope, plowing, and filling of cracks.

I now give the estimated quantities of material needed and cost of same to raise and secure the levees between Warsaw and Quincy, Ill.:

ESTIMATE.

602,643 cubic yards earthwork, at 12½ cents	$75,330.38
1,200 cubic yards riprap, at $2	2,400.00
Engineering contingencies, about 10 per cent	7,769.62
Total	85,500.00

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers.

X 9.

SURVEY OF WEST BANK OF THE MISSISSIPPI RIVER FROM FLINT CREEK TO THE IOWA RIVER.

[Printed in House Ex. Doc. No. 161, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 22, 1894.

SIR: The river and harbor act of August 17, 1894, provides that the Secretary of War "shall cause a survey to be made on the west side of the Mississippi River, commencing at the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river to the mouth of the Iowa River," with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along that part of the river and deepening the channel.

The duty of making this survey was assigned to Maj. Alexander Mackenzie, Corps of Engineers, and I have now the honor to submit the accompanying copy of that officer's report of December 14, 1894, with map,* of the results of the survey provided for. He estimates that an artificial bank to prevent overflow of west bank of Mississippi River from Flint Creek to the Iowa River will cost $305,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 14, 1894.

GENERAL: The river and harbor act of August 17, 1894, contains the following item:

And out of said appropriation he (the Secretary of War) shall cause a survey to be made on the west side of the Mississippi River, commencing at the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river to the mouth of the Iowa River, * * * with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel.

* Omitted. Printed in House Ex. Doc. No. 161, Fifty-third Congress, third session.

By letter of the Chief of Engineers, dated August 20, 1894, this survey was assigned to me. The field work was performed by a party in charge of Surveyor E. E. Barrett, which happened to be in the vicinity engaged on a survey of the main river, during September and October, 1894.

My understanding of the intention of Congress in ordering this survey is that the Government desires an estimate of the cost of preventing the overflow of the west bank of the river between the points named by the erection of artificial banks where needed.

A carefully located transit line was run from a point above high water on the Iowa River, down the south bank of that river to its mouth, thence down the west bank of the Mississippi River to the mouth of Flint Creek, and up that creek to high ground at the foot of the bluffs.

Branch lines were also run on both sides of De Soto Creek from the main line to points above high water. A line of levels was run over the entire length of the transit lines. Topography was taken adjacent to the transit lines, but no attempt was made to accurately ascertain the topographical features of the bottom lands between the river and the bluffs. Complete topographical information will be soon available from surveys made by the Mississippi River Commission, whose maps are now in process of publication.

The questions of outlets and interior drainage have not been considered.

An earthen bank is estimated for, with a slope of 3 to 1 on the river side and 2 to 1 on the inside, with 4 feet width of crown, to reenforce and raise the natural bank where necessary, and following the transit lines as above described. The grade of the top of the bank is placed at 3 feet above high water of 1888, which will probably be of sufficient elevation to restrain any flood that is likely to occur.

The average height of artificial bank will be about 8½ feet and its length 42 miles.

The accompanying tracing gives the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. There are also on the tracing a small-scale map showing the river and country adjacent, and a detailed estimate of quantities.

Estimate for artifical bank to prevent overflow of west bank of Mississippi River from Flint Creek to the Iowa River.

1,855,193 cubic yards earthwork, at 15 cents	$278,278.95
Add about 10 per cent for engineering and contingencies	26,721.05
Total	305,000.00

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX Y.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA, OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT ST. PAUL.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mississippi River above Falls of St. Anthony, Minnesota.
2. Construction of reservoirs at head waters of Mississippi River.
3. Operating and care of reservoirs at head waters of Mississippi River.
4. Chippewa River, including Yellow Banks, Wisconsin.
5. St. Croix River, Wisconsin and Minnesota.
6. Minnesota River, Minnesota.
7. Red River of the North, Minnesota and North Dakota.
8. Gauging Mississippi River at or near St. Paul, Minn.
9. Surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers.

EXAMINATIONS.

10. Minnesota River, Minnesota.
11. Big Stone Lake, Minnesota.
12. Red Lake River, Minnesota.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 10, 1895.

GENERAL: I have the honor to transmit herewith reports upon the works for improvement of rivers and harbors in my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

Y 1.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA.

This stretch of river extends from St. Anthony Falls to Grand Rapids, Minn., a distance of 337 miles. The project for improvement and estimates of cost were submitted in Major Farquhar's report on the

survey, dated February 8, 1875, and printed on pages 441–453, Annual Report, Part II, 1875. The report gives two estimates, one for a channel 5 feet deep and one for a channel 3 feet deep. In each case the river was divided into three sections.

Estimate for a channel 5 feet deep at lowest stage of water.

1. Falls of St. Anthony to St. Cloud, 78 miles, construction of wing dams and dredging (estimated cost)	$144,667.50
2. St. Cloud to Conradi Shoals, 42 miles, construction of wing dams, removal of bowlders, and construction of 4 locks and dams (estimated cost)	1,957,783.75
3. Conradi Shoals to Grand Rapids, 217 miles, dredging, removal of bowlders, and the construction of wing dams (estimated cost)	54,127.50
Total cost	2,156.578.75

Estimate for a channel 3 feet deep at lowest stage of water.

1. Falls of St. Anthony to St. Cloud, 78 miles, construction of wing dams and dredging (estimated cost)	$75,390.00
2. From St. Cloud to Conradi Shoals, 42 miles, construction of wing dams, removal of bowlders, and construction of 4 locks and dams (estimated cost)	1,943,210.00
3. From Conradi Shoals to Grand Rapids, 217 miles, dredging, removal of bowlders, and the construction of wing dams (estimated cost).	11,620.50
Total cost	2,030,220.50

The project and estimates for the 5-foot channel seem to have been adopted.

The appropriations for 1874 and 1876 were expended on the first section (Falls to St. Cloud). Steamboat navigation having discontinued on that section the third appropriation, that of $15,000, by act of Congress approved June 14, 1880, was applied to the upper 130 miles (Aitkin to Grand Rapids) of the third section, as have been all subsequent appropriations for improving the river above the Falls of St. Anthony, except the appropriation made by act of Congress approved September 19, 1890, which was applied to the upper 185 miles (Brainerd to Grand Rapids) of the third section. In 1889 the estimate for improving the upper 130 miles (Aitkin to Grand Rapids) of the third section was placed at $63,000, including the $45,000 previously appropriated. In the same report the officer asked for an appropriation of $18,000 to complete the work over this stretch. The amount was given in the act approved September 19, 1890, and subsequently expended in the completion of the necessary improvements, and also in extending navigation from Aitkin to Brainerd, 55 miles.

Before work of improvement commenced under the present plan the stream between Grand Rapids and Aitkin was so obstructed by snags, bowlders, and leaning trees that at fair stages of water navigation was difficult, and sometimes almost impossible for steamers drawing more than 3 feet of water.

The amount expended to June 30, 1893, including outstanding liabilities, $45,000 on first section and $63,000 on upper 185 miles of third section. With the latter amount there has been produced a general depth of 3 feet at low water. A few snags, bowlders, and leaning trees offered some obstruction, but did not seriously interfere with navigation. This improvement, though not complete for 5 feet depth as called for in the project, is yet ample for present needs; furthermore, the three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon to provide sufficient water and depth for the steamboats on the river at and above Brainerd.

There being no demand at present for navigation between Brainerd and Minneapolis, no further appropriation is now asked for. The time will come when this should be done. I will say, in conclusion, that this reach can be placed in excellent navigable condition at quite a reasonable expense.

Last season there was but one steamer on the river. She ran irregularly between Aitkin and Grand Rapids. During the winter of 1889–90 the Duluth and Winnipeg Railroad Company constructed a line from Cloquet, a point on the St. Paul and Duluth Railroad, to La Prairie. They have since extended their line through and beyond Grand Rapids. This road has ruined the river traffic.

In 1889, Maj. C. J. Allen reported:

The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitkin and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that, though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to $1 per 100 pounds, while in 1883, 1884, 1885, and 1886 the rates were reduced to 20 to 40 cents per 100 pounds. The last-named figures were obtained in 1886, at which time there were three steamboats engaged in freighting and carrying passengers between Aitkin and Grand Rapids. The country bordering the river north of Aitkin is becoming more and more settled, and there is no doubt that the improvement of the river already effected by the U. S. Government has largely contributed to the increase in settlement.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1894, $247,454.02; value of domestic exports for same period, $222,203.

Abstract of appropriations.

By act approved—	
June 23, 1874	$25,000
August 14, 1876	20,000
June 14, 1880	15,000
March 3, 1881	10,000
By act passed August 2, 1882	10,000
By act of August 11, 1888	10,000
By act approved September 19, 1890	18,000
Total	108,000

Money statement.

July 1, 1894, balance unexpended	$7.40
June 30, 1895, amount expended during fiscal year	7.40

COMMERCIAL STATISTICS.

Comparative statement of steamboat business on the Mississippi River between Aitkin and Grand Rapids, 1880–1894, inclusive.

Year.	Steamboats.	Freight carried (general merchandise).	Passengers.	Year.	Steamboats.	Freight carried (general merchandise).	Passengers.
		Tons.				*Tons.*	
1880	1	3,936	1,000	1888	3	2,650	2,960
1881	1	1,100	1,540	1889	2	3,500	5,250
1882	2	1,513	1,764	1890*	1	1,600	1,253
1883	2	1,400	1,100	1891*	†2	1,500	1,000
1884	2	8,000	1,346	1892*	†2	1,250	3,000
1885	2	2,500	2,400	1893*	‡1	401	750
1886	3	1,500	3,500	1894	‡1	Unknown.	Unknown.
1887	3	1,855	2,884				

* Amount of navigation and commerce 1890, 1891, 1892, and 1893 approximate.
† Tonnage of steamboats, 140 and 165 tons, respectively.
‡ Tonnage of steamboat, 140 tons.

Comparative statement of loose logs run on the Mississippi River above the Falls of St. Anthony.

Year.	Loose logs run.	Year.	Loose logs run.
	Feet, B. M.		*Feet, B. M.*
1880	226, 000, 000	1888	* 265, 000, 000
1881	238, 000, 000	1889	288, 000, 000
1882	285, 000, 000	1890	325, 669, 285
1883	420, 000, 000	1891	425, 716, 970
1884	367, 000, 000	1892	* 520, 000, 000
1885	317, 993, 000	1893	398, 000, 000
1886	282, 600, 000	1894	* 440, 000, 000
1887	* 265, 000, 000		

* Approximate.

Y 2.

CONSTRUCTION OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various annual reports of the Chief of Engineers. The résumé of the subject is given in the report of The Board of Engineers, printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted, and further examinations in 1880, the first cost of constructing forty-one reservoir dams in Minnesota and Wisconsin was placed at $1,809,083.50, exclusive of that of land damages, which could not be given in advance. (See p. 1762, Appendix W, to the Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnibigoshish, made by act of Congress approved June 14, that year. For the reasons given in the Annual Report for 1886 the work of construction was commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the head waters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

There are four completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883–84; capacity, 45,800,000,000 cubic feet.

At Leech Lake, completed in 1884; capacity, 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884; lift of dam increased in 1889; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity, 7,500,000,000 cubic feet.

Rules and regulations to control the use and administration of the reservoirs were formulated and approved by the Secretary of War February 21, 1889, as authorized by the river and harbor act of August 11, 1888.

Gaugings of the Mississippi River at St. Paul to determine the effects of reservoir water have been made to a limited extent during the past five years. They form the subject of a separate report. During May and June, 1891, men and materials for constructing a fifth reservoir at Sandy Lake were assembled, and the work of construction soon after commenced. The original plans for this dam were similar to those of the four dams previously constructed, but adapted to the conditions of Sandy Lake.

The river and harbor act of Congress approved July 13, 1893, appropriated, "for care and maintenance of reservoirs at the head waters of the Mississippi River, $60,000, of which $30,000 may be expended for the construction of a navigable pass through Sandy Lake Dam." This provision delayed the completion of the dam. The portion, about one-half the length, that was not affected by the change was practically completed in the fall of 1892. Work was resumed on the dam in 1893.

Since February 1, 1895, the expense of the care and maintenance of the completed reservoirs has been paid out of the appropriation for "operating and care of canals and other works of navigation, indefinite," and forms the subject of a separate report, which is referred to for a statement of the effect during the season of 1894 of the reservoir water upon the Mississippi River at St. Paul.

Amount expended upon this work, including examination at proposed dam sites, hydrological observations, land damages, amounts paid to commissioners in attempted settlement of awards to Indians, and care and maintenance of the works to the close of the fiscal year ending June 30, 1894, $771,093.67.

OPERATIONS DURING THE PAST FISCAL YEAR.

Sandy Lake Dam.—Continued work constructing this dam. At the beginning of the year the dam, exclusivive of the navigable pass, was completed. The latter would have been finished in June, 1895, but for the delay in the delivery of certain material. As it is, the dam and pass will be completed in October or November.

Connections with reservoir dams.—A wagon road and telephone line 19¼ miles in length, was built between the Leech Lake and Lake Winnibigoshish dams. The corduroy portions of the road need surfacing with sand to protect the peat covering against fire. This will be done in July. A telephone line 3 miles in length was also built from the Pokegama Falls Dam to the Duluth and Winnipeg Railroad station at Grand Rapids, Minn.

Communication between the dams and the St. Paul office is now tolerably good. There are telegraph and telephone connections to the Pokegama Falls and Sandy Lake dams; telegraph facilities to Brainerd, Minn., 30 miles south of the Pine River Dam; between the two is a good county wagon road; telegraph station at Deer River, the present terminus of the Duluth and Winnipeg Railroad. From the latter point to the Lake Winnibigoshish Dam (10 miles) mail and orders are carried by messengers; telephone line and wagon road between Leech Lake and Lake Winnibigoshish dams.

Eventually the railroad will be extended beyond the Lake Winnibigoshish Reservoir, and will pass within 5 miles of the dam. When this is done a short telephone line and wagon road should be built between them, and then the two dams will be as accessible as the Pine River and the Pokegama Falls dams are now. The Sandy Lake Dam is the most inaccessible.

There is a county road from Aitkin to the dam, 35 miles, but it is in wretched condition, and at certain seasons of the year impassable. A

wagon road, following approximately the telephone line from the dam to McGregor, 14 miles, is needed.

Survey for a proposed reservoir at Gull Lake.—The river and harbor act of August 17, 1894, contained the following item:

For care and maintenance of reservoirs at the head waters of the Mississippi River, $51,000, and so much thereof as shall be required shall be expended in completing connections with the reservoir dams, in completing Sandy Lake Dam, and any balance may be used for the construction of a reservoir and dam at Gull Lake, Minnesota: *Provided*, That the United States shall not be subject to any cost or expense for lands, mills, or other property necessarily taken or injured for the last-named reservoir and dam. * * *

In September, 1894, a survey party under Assistant Engineer A. O. Powell was placed in the field and remained until the middle of February, 1895. The party made the survey for the reservoir, and also an examination to determine the possibility of increasing the water supply by diverting into Gull Lake a portion of the freshet discharges from the Crow Wing River.

Areas and elevation of low-water surfaces in the lakes composing the proposed Gull Lake Reservoir.

No.	Name of lake.	Area.	Elevation of water surface, winter of 1894–95.	Low-water elevation, survey of 1880.	Elevation of water surface after ditches between lakes are dredged and protected against filling up by wave action.
		Square feet.	*Feet.*	*Feet.*	*Feet.*
1	Gull	433,365,000	1,195.5	1,191.8	1,194
2	Lake No. 1	800,000	1,196.5	1,195.6	1,194
3	Love	3,468,000	1,195.7	.....	1 194
4	Upper Gull	23,239,000	1,195.5	1,191.8	1,194
5	South Branch	10,010,000	1,195.5	1,192.7	1,194
6	Lake Roy	13,492,000	1,195.85	1,191.9	1,194
7	Three Mile	9,912,000	1,195.85	1,191.9	1,194
8	Cullen No. 1	24,746,000	1,198.1	1,193.5	1,195
9	Cullen No. 2	17,572,000	1,198.1	.....	1,195
10	Cullen No. 3	20,526,000	1,198.1	.....	1,195
11	Round	72,041,000	1,196.55	1,192.4	1,194
12	Long	271,471,000	1,198.1	1,196.6	1,194
13	Bass	9,645,000	1,198.8	1,194.9	1,194
14	Fish Trap	12,944,000	1,199.8	.....	1,200
15	Rice	6,971,000	1,200.5	1,197	1,200.5
16	Hubert	55,745,000	1,199.2	1,199.1	1,194
17	Little Hubert	8,322,000	1,200	1,194.7	1,194
18	Gladstone	19,203,000	1,201.9	1,197.1	1,194
19	Little Gladstone	1,857,000	1,201.6	.....	1,194

Several small ponds and the overflowed lands are not included in the above areas. Their omission will not materially affect the result.

The water in the first seven lakes enumerated in the list were raised last fall and winter above low-water stage by the lumberman's dam at outlet of Gull Lake, which was partially closed.

The elevations are approximate sea elevations. The base of rail on west end of Northern Pacific Railroad Bridge over Mississippi River at Brainerd, Minn., is assumed at 1,213.64 feet, and the U. S. bench mark (copper bolt in stone monument), located in southeast corner of Northern Pacific Sanitarium Grounds, Brainerd, Minn., 1,209.81 feet.

The drainage area of the Gull Lake system is 287 square miles.* The available supply of water for the climatic conditions at the head waters of the Mississippi is an average volume of three-tenths ($\frac{3}{10}$) of a cubic

* Appendix Z, Annual Report, 1894, p. 1704.

foot* per second per square mile of watershed which gives an average discharge of 86 cubic feet per second for the Gull Lake system.

If the water is held for nine months in the year and released during the low-water months of August, September, and October, the increment to the volume of the Mississippi River would be 344 cubic feet per second for 3 months. One year's supply aggregates 2,712,096,000 cubic feet.

To impound this quantity of water in a reservoir consisting of the first twelve lakes in the list and deepening their connections by dredging will require a dam to raise the water surface to an elevation 1197.10 feet, assuming that Gull Lake should never be drawn down below elevation 1,194 feet. A dam controlling water in the same lakes to a height of 1200.10 feet above the sea would hold back two years' supply. Bass, Hubert, Little Hubert, Gladstone, and Little Gladstone lakes have no outlets. They could be connected with Round Lake by short canals, but the expense of doing so would not be warranted unless the reservoir was to be filled to a height of 1,206 feet by the Crow Wing River water.

The examination of the country between the south arm of Gull Lake and the Crow Wing River showed that the surplus water of the latter could be diverted into Gull Lake. A yearly supply of 9,186,032,500 cubic feet from this source, in addition to the volume naturally tributary to Gull Lake, would raise the water surface in the reservoir to an elevation of 1,206 feet above the sea, and would furnish a discharge of 1,530 cubic feet per second for 90 days, or 1,148 cubic feet for 120 days. The reservoir would be one of the most efficient in the system. It would have the merit of being near the head of navigation of the Mississippi River and what is of more consequence it could be filled each year.

The feasibility of the plan is dependent upon the cost, which can only be ascertained after a careful survey for a water course between the Crow Wing River and the south arm of Gull Lake and of Gull River below the dam site, the latter for the purpose of learning the capacity of the river for discharging a volume of 1,100 to 1,500 cubic feet per second.

The survey made last winter locates the 1,206-foot contour within the reservoir basin. The maps have only recently been far enough advanced to show the descriptions of the flooded areas. The procurement of flowage rights by voluntary assignment from property owners has progressed as rapidly as could be expected. So far about 70 per cent of the lands that will be affected by a maximum flowage (elevation, 1,206 feet) are either United States water-reserve lands, State lands over which the right to flow has been ceded to the United States, or private lands that the owners have quitclaimed to the Government the flowage privilege. The lands remaining to be acquired embrace a few tracts of improved property, and payment for damages will be demanded before they are released. The cost of land damages for a low dam to hold one year's supply of water from the Gull Lake Watershed only is estimated at $9,000; to hold two years' supply, $15,000.

The estimate of damages for a full reservoir to 1,206 feet elevation is not submitted, as it properly belongs to a future estimate on the cost of creating a reservoir of that magnitude.

In building the dam it is considered economy to construct the foundation to support a 14-foot dam, and then if the reservoir supply should afterwards be increased by the Crow Wing water, the dam could be raised to that height at comparatively small expense.

* Appendix Z, Annual Report, 1894, p. 1709.

The funds available are not sufficient to commence constructing the reservoir even if the question of damages was waived.

The estimate of money required is:

For building low dam and ditches between Gull and Round lakes and Round and Long lakes	$70,000
For land damages	15,000
For survey upon which to base an estimate of the cost of diverting surplus water from the Crow Wing River into the reservoir, holding same, and afterwards releasing it	5,000
For a wagon road from Sandy Lake Dam to McGregor	5,000
For hydrological and meteorological observations	15,000
Total	110,000

Amount expended during the fiscal year ending June 30, 1895, including outstanding liabilities, $38,398.85.

For commerce benefited by the reservoirs, reference must be made to the commercial statistics of the Mississippi River.

Abstract of appropriations.

By act—	
Approved June 14, 1880	$75,000.00
Approved March 3, 1881	150,000.00
Passed August 2, 1882	300,000.00
Approved July 5, 1884	60,000.00
Approved August 5, 1886	37,500.00
Of August 11, 1888	12,000.00
Approved September 19, 1890	80,000.00
Approved July 13, 1892	60,000.00
Of August 17, 1894	51,000.00
Total	825,500.00
Allotment per letter from office Chief of Engineers:	
November 9, 1881	1,572.15
January 20, 1882	176.00
January 18, 1888	643.85
May 11, 1888	8.60
Expenses of commissioners in attempted settlement of awards to Indians	333.73
Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam sites; letter from office Chief of Engineers, May 27, 1881	7,500.00
Expended by officer in charge in connection with the building and operating of five reservoir dams to June 30, 1895, including outstanding liabilities	799,258.19
Total allotted and expended to June 30, 1895, including outstanding liabilities	809,492.52
Estimated cost of the system (omitting that of land, etc., damages)	1,809,083.50
Amounts appropriated	825,500.00
Remaining to be appropriated	983,583.50

Money statement.

July 1, 1894, balance unexpended	$5,272.58
Amount appropriated by act of August 17, 1894	51,000.00
	56,272.58
June 30, 1895, amount expended during fiscal year	37,898.97
July 1, 1895, balance unexpended	18,373.61
July 1, 1895, outstanding liabilities	2,366.13
July 1, 1895, balance available	16,007.48

Amount (estimated) required for completion of existing project	983,583.50
Amount that can be profitably expended in fiscal year ending June 30, 1897	110,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Y 3.

OPERATING AND CARE OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The river and harbor act of August 17, 1894, made applicable to the reservoirs at head waters of the Mississippi River, "so far as concerns their care, preservation, and maintenance," the provisions of the general appropriation for "operating and care of canals and other works of navigation, indefinite" contained in section 4 of the river and harbor act of July 5, 1884.

January 25, 1895, an allotment of funds was made, as follows:

Watchmen and other employees	$3,690
Subsistence for same	900
Ordinary repairs	3,000
Repairs to Leech Lake Dam	10,000
Total	17,590

The expenses from February 1, 1895, were paid from this source.

There are four completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883–84; height of dam, 14 feet; capacity, 45,800,000,000 cubic feet.

At Leech Lake, completed in 1884; height of dam, 6 feet; capacity, 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884; height of dam, 7 feet, increased in 1889 to 9 feet; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; height of dam, 17 feet; capacity, 7,500,000,000 cubic feet.

A fifth reservoir at Sandy Lake is in process of construction and nearly completed.

The maximum quantity of water held in the reservoirs at any one time since their completion was:

In Lake Winnibigoshish Reservoir, August, 1893, 25,200,000,000 cubic feet.
In Leech Lake Reservoir, July, 1888, 17,850,000,000 cubic feet.
In Pine River Reservoir, July, 1888, 4,945,000,000 cubic feet.
In Pokegama Falls Reservoir. This reservoir can be filled each year.

The purpose of the reservoirs is to collect the surplus water principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but the control of extended floods or freshets is not expected.

EFFECT OF THE RESERVOIR WATER.

The Board of Engineers, in their report dated May 24, 1887, and printed on pages 1681–1698, Annual Report of the Chief of Engineers, 1887, express this opinion:

As far down as the mouth of the first considerable tributary, the St. Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the St. Paul gauge, i. e., from 1 foot to 18 inches of low-water stages.

My predecessor, in his annual reports for the years 1887, 1888, and 1889, has stated:

From such observations as means admitted of in 1885 and 1886, and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at St. Paul the effect of every 100 cubic feet per second of water

added to the river and steadily maintained was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each hundred cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886 that the effect of the liberated water from the reservoirs was the addition of 1 foot and upward to the depth at St. Paul during the dry periods of those years, the additional depth being due to elevation of water surface as well as to additional scour. (See Appendix A A, Annual Report, 1887.)

The benefit of the reservoir volume extended over some 425 (390) miles of river below Grand Rapids, the rapids being 388 (353) miles by river above St. Paul. Of the 425 (390) miles, 200 (165) are navigable by steamers.

The increase in channel depth at St. Paul due to the release of the stored-up water undoubtedly averaged, for the eighty-six days, 1 foot to 1½ feet. (See Appendix Z, Annual Report, 1888.)

The increase in channel depth at St. Paul due to the reservoir water undoubtedly averaged 1 foot during the low-water season of 1888. (See Appendix B B, Annual Report, 1889.)

The effect of the reservoirs on the navigable depth of water in the channel of the Mississippi River above the Falls of St. Anthony is not as conclusively shown as it could be. A series of hydrological and meteorological observations on the Mississippi and the principal tributaries above St. Paul, extending over a period of several years, would furnish information not only of great practicable value in the operation of the reservoirs, but would also be of scientific value in connection with the loss of river water by evaporation and filtration and in the progression (and even dispersion) of a flood wave. A commencement in this direction has been made by the provision for gaugings at or near St. Paul, but the money available for the purpose is inadequate for thorough work, and is only applicable near St. Paul. It is estimated that the sum of $15,000 per annum can be profitably expended in hydrological and meteorological investigation during a period of four years.

The two plates herewith show the effect of the reservoir water upon the Mississippi River at St. Paul during the low-water period of the years 1893–94.

The record is in conformity with the experience of previous seasons and indicates that about ten days elapse from the time the water is released from the distributing reservoir at Pokegama Falls before the first effect is felt at St. Paul, 357 miles by river below, and three or four days more for the full effect to be reached. The rise on the Signal Service gauge, St. Paul, in 1893 was 1 foot; in 1894, 1.3 feet. The increment to the volume at St. Paul was 1,800 cubic feet per second, or an increase of 40 per cent in 1893, and 1,900 cubic feet per second, or an increase of 55 per cent, in 1894.

Maintenance of existing structures during the fiscal year ending June 30, 1895:

Repairs to Lake Winnibigoshish Dam.—The gates were repaired and roller bearings placed on them. The hoisting machinery was also overhauled.

Repairs to Pokegama Falls Dam.—The top of the dam was redecked with 28,754 feet, B. M., of pine lumber.

Repairs to Pine River Dam.—Roller bearings were placed on 13 gates and also on 8 stop planks in the log sluice. One broken gatepost was replaced by a new timber.

Repairs to the Leech Lake Dam.—The repairs to the dam were not commenced. They will be made the ensuing year.

CARE OF RESERVOIRS DURING THE FISCAL YEAR ENDING JUNE 30, 1895.

A force of watchmen, consisting usually of two men at each dam, were employed in operating the dams and guarding United States property stored at them, and also in taking hydrological and meteoro-

logical observations. A force of three men in addition to the watchmen aided in the hydrological work. One assistant engineer, Mr. Archibald Johnson, at a salary of $180 per month, divided his time between the completed reservoirs and the construction of the Sandy Lake Dam.

Estimate for the fiscal year ending June 30, 1896, allotted June 15, 1895.

1 assistant engineer, 12 months, at $180	$2,160
1 watchman and head lock tender, 12 months, at $100	1,200
1 watchman, 12 months, at $75	900
2 watchmen, 12 months, at $60 each	1,440
3 watchmen, 12 months, at $50 each	1,800
3 watchmen, 12 months, at $30 each	1,080
1 recorder, 12 months, at $90	1,080
1 recorder, 12 months, at $75	900
1 boatman, 12 months, at $45	540
Subsistence of 11 employees, 12 months, at $20 each	2,640
Mileage and traveling expenses of employees	380
Ordinary repairs to Lake Winnibigoshish, Pokegama Falls, and Pine River dams	3,000
Rental of two transmitters and two receivers, Sandy Lake Telephone Line.	10
Rental of poles, Grand Rapids to Pokegama Falls, and space in Duluth and Winnipeg Railway depot at Grand Rapids	30
Contingencies and St. Paul office expenses	2,866
Total	20,026
Balance available from allotment made June 25, 1895, for repairs to Leech Lake Dam	10,000
Total available July 1, 1895	30,026

Money statement.

Allotted January 25, 1895		$17,590.00
Allotted June 15, 1895		20,026.00
		37,616.00
June 30, 1895, amount expended during fiscal year		5,704.86
July 1, 1895, balance unexpended		31,911.14
July 1, 1895, outstanding liabilities	$712.05	
July 1, 1895, amount covered back into the Treasury	1,173.09	
		1,885.14
July 1, 1895, balance available		30,026.00

Itemized statement of expenditures during the fiscal year ending June 30, 1895, from the indefinite appropriation for "operating and care of canals and other works of navigation, indefinite" in "care, etc., of reservoirs at head waters of Mississippi River."

Date.	To whom paid.	For what paid.	Amount.
1895.			
Mar. 1	Sundry persons	Pay roll, February, 1895	$650.00
7	.....do	.....do	80.00
	.....do	.....do	51.25
11	Beckfeldt & Mather	Cheese	2.80
	.....do	Mess supplies	306.57
13	St. Paul Foundry Co	Roller bearings	590.53
	W. J. & H. D. Powers	Dynamite, rope, etc	27.08
	John Jackson	Mess supplies, etc	23.20
	H. Rosenblatt	Team hire	10.00
	Fuller Bros	Subsistence	44.42
22	W. J. & H. D. Powers	Coal, iron, etc	9.75
	John Lyons	Hay	13.00
	St. Paul Foundry Co	Roller bearings	304.30
	M. Hagberg	Wheat, etc	5.85
26	H. Rosenblatt	Team hire	13.78
Apr. 1, 3	Sundry persons	Pay roll, March, 1895	650.00
3	.....do	.....do	468.78
	.....do	.....do	56.88
4	Maj. W. A. Jones	Mileage	26.14

Itemized statement of expenditures during the fiscal year, etc.—Continued.

Date.	To whom paid.	For what paid.	Amount.
1895.			
Apr. 5	Sundry persons	Pay roll, March, 1895	$80.00
11	W. A. Ross	Services	10.00
	Archibald Johnson	Traveling expenses	27.91
	Northern Pacific Express Co	Express charges	4.40
15	Goodyear Rubber Co	Rubber boots	32.30
	Geo. Snetsinger	Traveling expenses	1.25
	B. F. Kennedy	....do	5.65
	Sundry persons	Part pay roll for April, 1895	179.66
18	W. J. & H. D. Powers	Dynamite, etc	15.04
	Beckfelt & Mather	Ink	1.20
	A. D. Brooks & Co	Meat, etc	9.68
	H. Rosenblatt	Team hire	45.50
22	Northern Pacific Express Co	Express charges	5.10
	Boeringer & Son	Repair work	4.50
26	John Doran	Team hire, etc	12.00
	W. J. & H. D. Powers	Hardware	12.00
	Beckfelt & Mather	Mess supplies	70.94
25	Sundry persons	Part pay roll, April, 1895	81.33
26	A. Purdy	Fare by team	6.00
	M. Hagberg	Subsistence, supplies, etc	31.04
	Standard Paint Co	Paint, etc	27.23
30	Sundry persons	Part pay roll, April, 1895	176.00
	Richard Relph	....do	75.00
May 2	Sundry persons	Pay roll, April, 1895	270.00
8	....do	....do	80.00
11	Geo. Snetsinger	Traveling expenses	3.45
	....do	....do	7.90
	Duluth and Winnipeg R. R. Co	Express charges	1.65
15	North American Telegraph Co	Telegrams	3.16
	Griggs & Co	Subsistence	164.83
	D. M. Clark & Co	Iron and coal	2.73
	Beckfelt & Mather	Garden seeds	4.80
	Riddle & Son	Team hire	6.00
	M. Hagberg	Seeds	2.20
17	J. J. Howe Lumber Co	Pickets	14.00
20	Col. O. M. Poe	Mileage	93.06
24	R. E. Henneman	Services	8.50
27	Duluth and Winnipeg R. R. Co	Express charges	1.45
	A. C. Gould	Hauling	41.80
	....do	....do	2.56
31	Sundry persons	Pay roll, May, 1895	473.00
June 5	Archibald Johnson	Services	180.00
	Sundry persons	Pay roll, May, 1895	80.00
10	John Jackson	Plowing	3.20
	F. B. Lawrence	Team hire	7.00
	M. Hagberg	Potatoes	3.90
27	North American Telegraph Co	Telegrams	1.62
	Total		5,704.86

Outstanding liabilities June 30, 1895.

To whom owing.	On account of—	Amount.
Sundry persons	Pay roll, June 1-11, 1895	$172.32
Do	Pay roll, June 12-30, 1895	171.01
Do	Pay roll, June 1-11, 1895	29.33
Do	Pay roll, June 12-30, 1895	177.32
Freight accounts	Estimated	37.47
Archibald Johnson	Services	114.00
Western Union Telegraph Co	Telegrams	.91
Miles & Hale	Dry battery	.75
Boeringer & Son	Repair work	1.25
Cross Lake Logging Co	Meat, etc	4.05
American Bell Telephone Co	Rental	1.06
Duluth and Winnipeg R. R. Co	....do	1.58
J. D. Rasmusen	Repair work	1.00
Total outstanding		712.05
Expended to June 30, 1895		5,704.86
Total		6,416.91

Y 4.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 56 miles, to confine the low-water volume to a channel of nearly uniform width and depth, and in the revetment of the Yellow Banks (or high sand bluffs that border the river at a number of points) to prevent their erosion, and thereby relieve the channel of the river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks.

The river from Eau Claire to the mouth flows through an alluvial, sandy valley. The river banks of the bottom lands gradually decrease in height from Eau Claire to the head of the delta, 14 miles from the mouth; from here the banks are low and uniform. The main channel of the river flows along the west side of the delta; a secondary outlet, called Beef Slough, flows on the east. At the confluence of the Mississippi the two mouths are 9 miles apart.

The slope of the river from Chippewa Falls to Eau Claire varies from 1.07 to 1.79 feet per mile, except at the upper and lower dalles; at the former the slope for 2 miles averages 4.80 feet per mile; at the latter for seven-eighths of a mile it averages 7.54 feet per mile. From Eau Claire to the mouth it varies from 1 to 2.30 feet per mile. The total fall from the foot of the rapids below the falls to Eau Claire is 43.45 feet; distance, 17⅛ miles; and from Eau Claire to the mouth the fall is 93.42 feet; distance, 56¼ miles. Total fall from Chippewa Falls to the mouth is 136.87 feet; distance, 74 miles.*

It is convenient to divide the river into two portions—the upper section, from Eau Claire to Waubeek Yellow Banks, 36 miles in length, and the lower section from Waubeek Yellow Banks to the mouth, 20 miles. The upper section is for the greater part narrow, or, more properly, is a series of compound curves—important condition for a stable channel in a river with sand bed during fluctuating stages of water, because the thread of the current, and hence the body of the water, follows the convex curve unless of too large a radius. Volume of water and slope determine the depth. The banks on this section are harder and contain more gravel than those on the lower section.

On this reach there are three shoal sand bars, viz, Rumseys, Upper Goose Lake, and Fairplay bars. The channel over them at a zero reading of the gauge is as frequently good as poor. In addition there are five gravel bars, viz, Longreach, Drurys, Sebastopol, Lower Goose Lake, and Hawkins Bend bars. These do not often interfere with the passage of rafts and boats except when the Missisippi River Logging Company close their dam at Little Falls in order to fill their reservoir for flooding purposes.

The bar at Fairplay is hard (composed of a mixture of sand and gravel) and partakes more of the characteristics of a gravel than a sand bar—i. e., its shape, size, and height are more permanent and usually shoal during low water only, whereas a submerged sand bar such as are found in the lower portion of the river is constantly being altered in position, size, shape, and depth of water on crest, depending upon the current, stage of water, proximity of other bars, etc.

The lower section is wide and nearly straight. The position, depth, and width of the channel is constantly being altered. The greater

* Manuscript report of Assistant Engineer Joseph E. Turner, January 18, 1875.

changes are produced by a temporary rise, natural or artificial. To permanently improve this reach it will be necessary to construct works of improvement over its entire length at a cost of $15,000 per mile.

Excessive floods occurred during the years 1838, 1847, 1855, 1857, 1858, 1866, 1880, and 1884. The two latter took place after the Government had undertaken the improvement of the river. The one of 1880 caused a cut-off from Horse Slough to the head of Dead Lake. The closing of the cut-off (1882–83) was an expensive operation. The flood of 1884 changed the channel of the river at Eau Claire and necessitated the removal by the Government of 10 piers that had been built by the Daniel Shaw Lumber Company to assist in handling their rafted lumber. For a description of all the floods as well as a report on the "Causes of the extraordinary overflows of the Chippewa River, Wisconsin, and what means, if any, can be adopted to prevent their recurrence," see pages 1726–1733, Annual Report, Part II, 1887.

The logging and rafting interests largely control the volume of water during low stages by means of three dams and reservoirs—one at Little Falls, 40 miles above Eau Claire; one at The Dalles, in Eau Claire, and one at Menomonie, on the Menomonie River. The water collected by these reservoirs is used during the low-water period for flushing the river and creating an artificial rise on which lumber and logs are floated out into the Mississippi. The effect of floods on the upper section is to produce, during the time of the flood, an excellent channel, without any seriously detrimental effects thereafter. The location, shape of the channel, and cross section below low water usually remains unchanged. There could be no detrimental effects were the bed and banks harder and the river a complete series of curves of the proper radii. After the subsidence of the rise the river (on this stretch), as a rule, resumes its course almost identically. The effect on the lower section is different. The tendency of every rise is to level the bars, making the bed of the river of a more uniform cross section. A fall thus leaves the river flat and wide, sometimes requiring weeks before the water gathers and cuts a channel over the bars, as it will eventually do. During the flood there is, of course, an increased depth of water. Occasionally the flood will improve the channel on some bars. The effects of the floods on the whole are exceedingly detrimental to a good channel. One of the requisites for maintaining the greatest channel depth in a sediment-bearing river is a uniform stage of water.

YELLOW BANKS.

Where the bottom lands are bordered by high sand prairies the river occasionally impinges against them, forming what are locally known as "yellow banks." They are from 80 to 100 feet high with steep slopes running to the water's edge. The protection of these banks against erosion was urged by General Warren in 1868,* by Major Farquhar in 1875,† and by Major Allen in 1881‡ and 1883,§ but no attempt was made in that direction until Congress made an appropriation of $30,000 for that specific purpose by act passed August 2, 1882. Eight thousand dollars had been appropriated for their protection in the act of March 3, 1879, which was soon afterwards (act approved June 19, 1879)

* Page 369, Annual Report, 1868.
† Page 708, Part I, Annual Report, 1876.
‡ Page 1749, Part II, Annual Report, 1881.
§ Page 1439, Part II, Annual Report, 1883.

made available for channel improvements, and was expended for the latter purpose, as the completion of the jetties at the mouth and construction of new dams near the mouth were considered* the more important work.

The appropriation of 1882 was expended the following year. Since then no work of consequence has been done.

From August 2, 1882, until the passage of the river and harbor act of August 11, 1888, the yellow banks were considered as a separate and distinct work.

The question of the immediate importance of protecting the yellow banks is a debatable one. There is a small percentage of gravel in the sand banks which, as the banks have been eroded, has collected at the foot and formed a natural revetment at low and medium stages. High stages still continue to erode the banks, but the sand contributed from this source is small in comparison with that from the shore line in general.

The yellow banks below Eau Claire are five in number:

1. A bank about 1 mile below Eau Claire, about 2,000 feet in length and 20 feet in height.
2. A high bluff, known as Twelve Mile Bluff, 12 miles below Eau Claire, 6,300 feet in length and about 175 feet in height.
3. The Mary Dean Bank, 19 miles below Eau Claire, 6,900 feet long and 145 feet high.
4. Rumsey's Yellow Bank, 22 miles below Eau Claire, 4,700 feet long and 140 feet high.
5. Waubeek Yellow Bank, 36 miles below Eau Claire, 3,800 feet long and 135 feet high.

The slopes on these banks are about 1½ on 2.

The first official reference in the reports of the Chief of Engineers to the Chippewa River was made by Maj. G. K. Warren, page 369, Annual Report, 1868, in the following paragraphs:

Congress has also been memorialized to aid in the improvement of this river. I have made considerable examination of it in studying its relations to the Mississippi, which it closely resembles in many of its features. Stone and brush dams are as applicable to it as to any river I have seen, but I can not submit a thorough plan of them until a survey is made, for which I have estimated $10,000.

There are three places known as yellow banks where the Chippewa washes against terraces of sand about 100 feet in altitude, where the sand slopes at an angle of 30°, and is continually sliding into the water. It is believed these yellow banks contribute a large part of the sand obstructing the river, and that it is desirable to stop the sliding of the sand. This can be done by piling and adding brush and stone, and I recommend $5,000 for this purpose.

The river and harbor act of Congress approved June 10, 1872, provided for an examination or survey, or both, "of Chippewa River up to Chippewa Falls, Wis." Colonel Macomb was charged with the examination, but it does not appear to have been made. The act of Congress approved June 23, 1874, called for an examination of the river below Chippewa Falls, Wis. Under this act an allotment of $4,664.86 was made. Major Farquhar's report of the survey, dated January 30, 1875, and printed on pages 373–380, Part I, Annual Report, 1875, gives a concise description of the river and of the main obstructions to navigation. The character of work to be done, as proposed in the report, has formed the basis of all improvements made to date, though the location and extent of dams have since been modified.

*Major Allen's letters to the Chief of Engineers, dated April 14, 1879, and July 22, 1879.

A résumé of the estimate submitted January 30, 1875, is as follows:

Between Chippewa Falls and Eau Claire:		
Channel improvements for raft navigation, items 1 to 11, inclusive, except Nos. 3 and 10	$26,793	
Protection of two yellow banks, items 3 and 10	28,490	
		$55,283
Between Eau Clare and the mouth:		
Channel improvement for raft and steamboat navigation, items 12–44, inclusive, except Nos. 18, 25, 27, and 36	$49,497	
Protection of four yellow banks, items 18, 25, 27, and 36	62,865	
		112,362
Total		167,645

The river and harbor act approved March 3, 1875, directed an examination or survey, or both, of the Chippewa River, Wisconsin. An allotment of $1,800 was made, which was applied to detailed surveys of six localities. Major Farquhar's report of the survey, dated December 13, 1875, and printed on pages 707–709, Part I, Annual Report, 1876, somewhat increased the estimate of the previous year.

Correcting the estimates of 1874 by those of 1875 gives the following estimate of cost:

Between Chippewa Falls and Eau Claire:		
Channel improvement for steamboat navigation	$464,733.11	
Protection of two yellow banks	28,490.00	
		$493,233.11
Between Eau Claire and the mouth:		
Channel improvement	73,539.50	
Protection of four yellow banks	62,865.00	
		136,404.50
Total		629,627.61

In the first report upon the improvement of the river (p. 574, Part I, Annual Report, 1877), as in all subsequent reports, the above estimate for river between Eau Claire and the mouth was given as $139,892.50, of which sum $64,102.50 was for protection of four yellow banks. The reports do not show how these amounts were arrived at. In 1877–78 a dam and lock were built at Eau Claire (Lower Dalles) by a private company under a charter granted by the State of Wisconsin. The dam was designed to facilitate the handling of loose logs and for water-power purposes. By this time it had become evident that the commerce on the river would not extend above Eau Claire, and since 1877 the latter place has been considered the head of navigation, though it was not until the passage of the river and harbor act of 1886 that Congress limited the expenditure of the appropriation from "Dalles Dam to its mouth."

In 1883, 1887, and again in 1888, the estimate of cost of improving the river below Eau Claire was revised by Maj. Charles J. Allen.

Estimate of 1883: *		
To complete channel improvements	$49,476.35	
Amounts previously appropriated and expended for channel improvements	83,000.00	
		$132,476.35
Protecting five yellow banks		96,000.00
Total		228,476.35

* Pages 1440–1443, Part II, Annual Report, 1883.

Estimate of 1887: *		
To complete channel improvements	$55,522.96	
Amounts previously appropriated	116,750.00	
		$172,272.96
Protecting five yellow banks		96,000.00
Total		268,272.96
Estimate of 1888: †		
To complete channel improvements	59,737.72	
Amounts previously appropriated for channel improvements	116,750.00	
		176,487.72
Protecting five yellow banks		96,000.00
Total		272,487.72

Previous to 1882 several steamboats did a thriving business between Eau Claire, Wis., and Reeds Landing, Minn., opposite the mouth of the Chippewa. During that year the Chippewa Valley division of the Chicago, Milwaukee and St. Paul Railroad was completed. This line parallels the river from Chippewa Falls to the mouth, with a branch at Red Cedar paralleling the Menomonie River as far as Menomonie. The railroad destroyed the steamboat business. The boats were taken off the week the railroad was opened for travel. Since then the traffic on the river has been confined to the floating of rafted lumber and the running of loose logs. This class of commerce, however, is enormous and furnishes more than 50 per cent of the business done on the Upper Mississippi River.

For years Beef Slough has been utilized by the Mississippi River Logging Company for holding, sorting, and rafting the loose logs run down and out of the Chippewa. During the winter of 1882–83 the company built a dam at the head of Horse Island in an effort to arrest the shoaling at the head of the slough. The dam was built upstream from the head of the island parallel with the shore lines, and was virtually an extension of the island. The dam failed to produce any beneficial effects; the shoaling continued at the head and at other points in the slough until 1889, when the company were obliged in low water to run their logs out of the river by the west or main channel, collecting them at West Newton Slough, on the Mississippi River. In 1891 they transferred all their operations to the latter place.

The practice of running loose logs down the river was bitterly opposed by the rafting and steamboat interests. The contention between the conflicting sides culminated in a series of law suits. The final decision was rendered by the United States circuit court at Madison, Wis., in favor of the Beef Slough Company. ‡

Congress evidently considered the running of loose logs as legitimate navigation, for in the river and harbor act approved June 18, 1878, they legislated:

Provided, That nothing herein shall be construed nor shall any expenditure of this appropriation be made so as to affect existing legal or equitable rights in or upon the said Chippewa River or its branches, whether such arise under the laws of the United States or the State of Wisconsin.

And in the acts approved March 3, 1879, June 14, 1880, March 3, 1881, and act passed August 2, 1882, Congress added this proviso to the appropriations:

That nothing shall be done nor shall any improvement be made on the said Chippewa River under or in pursuance of this act or the appropriation hereby made

* Page 1701, Part II, Annual Report, 1887.
† Page 1544, Part III, Annual Report, 1888.
‡ Page 145, Vol. I, Federal Reports.

which shall directly or indirectly prevent, interfere with, or obstruct the free navigation of said river, as heretofore, by steamboat or other water craft, or the free use thereof, as heretofore, for the running, floating, guiding, or sheering of loose logs or rafts of lumber, or logs upon or down the same, or which shall directly or indirectly prevent, obstruct, or interfere with the use of any slough, arm, or branch of the said river, as heretofore, for the holding, assorting, or rafting of logs therein.

The work of improvement to June 30, 1893, has provided a permanent channel 3 feet deep over the bar at the mouth of the river and materially increased the depths over the Durand, Plum Island, Eau Galle Flats, Plum Island Flats, Battle Island, Wacouta Island, and Flower Pot Island bars, besides straightening a difficult piece of river at the Madison Street Bridge, in Eau Claire, and the stoppage of a dangerous cut-off at Dead Lake. Where the improvements have been completed the channels are 3 feet or more in depth. The channel improvements have effected a reduction of 10 cents per thousand in the cost of running rafted lumber from Eau Claire to the mouth of the river.

The jetties at the mouth of the river have been of incalculable benefit to raft and steamboat navigation, securing a stable channel of sufficient depth where before improvement commenced there was a broad bar intersected by shallow, shifting channels, passable with great difficulty at times of low water by rafts and steamers.*

The total expenditures, including outstanding liabilities, to June 30, 1894, have been $171,750. A close approximation to the cost of items of work done is as follows:

Yellow banks protection		$30,000.00
10 piers removed from channel at Shawtown, Eau Claire, at $46.22		462.19
432 piles, at $3.25	$1,404.00	
266.6 cords gravel, at $3	799.80	
8,636.3 cords stone, at $10	86,363.00	
12,260.7 cords brush, at $4.30	52,721.01	
		141,287.81
Total		171,750.00

The cost per linear foot of the dams and shore protections is, 18,471 linear feet of dams and shore protections, at $7.65, $141,287.81; or counting the Three Mile Prairie shore protection that has been washed out, 19,806 linear feet of dams and shore protections, at $7.13, $141,287.81.

OPERATIONS DURING THE PAST FISCAL YEAR.

One new dam (Plum Creek Dam) was built across the slough between Plum Island and the right shore. In 1882 a dam was built across the head of the slough, but it has proven so hard to maintain that it was deemed economy to build an additional one farther down in the slough at a narrow place, and at right angles to the thread of the current.

Plum Island Flats Dams Nos. 1 and 3 were repaired. Part of the stone for two new dams at Wacouta Island was purchased.

The appropriation in the river and harbor act of August 17, 1894, included the cost of "a survey of the river for 2 miles south of the Dells Dam." The survey was made but the map is not yet prepared.

In this connection I desire to state that the appropriations for this improvement since 1886 have been inadequate to maintain existing dams in good condition, and at the same time relieve navigation interests by the construction of new works on bars that are serious obstructions to the passage of rafts. A connected survey of the river is needed, particularly of the lower 20 miles from Waubeek Yellow Bank to the mouth. The necessity for this survey has been repeatedly urged by my predecessors. In order to obtain the best effect from works of improvement they should be located as parts of a systematic plan. This can only be done by aid of a complete survey.

* Major Allen, page 1699, Annual Report, Part II, 1887.

The following statement shows the cost of work during the past year:

Care of property, superintendence, and St. Paul office expenses		$1,086.83
Survey for 2 miles south of the Dalles Dam		309.83
Repairs to Plum Island Dam No. 1:		
133 75/128 cords brush, at $1.75	$233.79	
137½ cords brush, at $1.40	192.50	
Labor and supplies collecting 12 cords stone, placing 65½ cords stone, and 271 19/128 cords brush	618.48	
		1,044.77
Building Plum Creek Dam:		
122 44/128 cords brush, at $1.40	171.72	
25 cords stone, at $4.50	112.50	
Labor and supplies placing above material	354.77	
		638.99
Repairs, Plum Island Dam No. 3:		
16¾ cords brush, at $1 40	23.62	
Labor and supplies placing same	30.00	
		53.62
Material on hand at Plum Island:		
46 19/128 cords brush stumpage, at 15 cents	7.03	
Labor and supplies, cutting and hauling	79.12	
		86.15
Material on hand at Five Mile Bluff:		
40 cords stone, at $4.50		180.00
Total expense for the year		3,400.19

Distribution of material on hand June 30, 1894.

Rotted and destroyed by high water, 81.12 cords brush, at $1.72	$140.51
Repairs, Plum Island Dam No. 1, 53⅓ cords stone, at $5	205.62
Total	346.13

Statement of material on hand June 30, 1895.

At Plum Island, 46 19/128 cords of brush, at $1.84	$86.15
At Five Mile Bluff, 40 cords stone, at $4.50	180.00
Total	266.15

Dams, jetties, revetments, and Yellow Banks protections constructed and kept in repair, 1877 (when work was begun) to fiscal year ending June 30.

Description.	Locality.	Constructed during fiscal year.	Yellow Banks protection.	Channel improvement.
			Lin. ft.	*Lin. ft.*
East jetty (2,110 linear feet)	Mouth of river	1878–1879		6,123
West jetty (4,013 linear feet)	do	1878		
Shore protections	do	1888		654
Dam	Little Missouri Chute	1880		300
Dam	Flower Pot Bar	1880–1882		2,065
Shore protection, 1,335 feet (since washed away).	Three Mile Prairie	1883		
Dam No. 1	Dark Slough	1882		225
Dam No. 2	do	1889		319
Dam	Wacouta Island	1883		325
Dam No. 1	Five Mile Bluff	1887		1,000
Dam No. 2 (shore connection only)	do	1887		75
Dam	Battle Island	1882		820
Dam No. 1	Plum Island Flats	1889		1,305
Dam No. 2	do	1892		1,000
Dam No. 3	do	1892		500
Dam	Jack Staff Island	1882		275
Dam	Plum Creek	1894		200
Dam	Plum Island	1882		400
Dam	Dead Lake Cut-off	1883		325
Dam No. 1	Eau Galle Flats	1893		750
Dam No. 1 (lower)	Durand	1884		600
Dam No. 2 (upper)	do	1884		600
Dam	Eau Claire	1887		810
Protection, Yellow Banks	Waubeek	1883–1884	2,989	
Protection, Yellow Banks	Rumsey	1883–1884	1,850	
Protection, Yellow Banks	Meridian	1883–1884	139	
Total			4,978	18,671

Mr. A. O. Powell, assistant engineer, has had local charge of the improvement of the river, as well as of the St. Croix River, in addition to duties as assistant engineer on all the works pertaining to this district.

Expenses during the fiscal year ending June 30, 1895, including outstanding liabilities, $3,400.19.

The sum of $70,000 can be profitably expended during the fiscal year ending June 30, 1897.

For channel improvements	$60,000
For survey	10,000
Total	70,000

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1894, amounted to $363,496.18.

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Approved August 5, 1886	$18,750
Approved June 8, 1878	10,000	Of August 11, 1886	10,000
Approved March 2, 1879	8,000	Approved September 19, 1890	10,000
Approved June 14, 1880	10,000	Approved July 13, 1892	5,000
Approved March 3, 1881	10,000	Of August 17, 1894	10,000
Passed August 2, 1882	65,000		
Approved July 5, 1884	15,000	Total	181,750

Money statement.

July 1, 1894, balance unexpended	$49.74
Amount appropriated by act of August 17, 1894	10,000.00
	10,049.74
June 30, 1895, amount expended during fiscal year	3,087.51
July 1, 1895, balance unexpended	6,962.23
July 1, 1895, outstanding liabilities	362.62
July 1, 1895, balance available	6,599.61
Amount (estimated) required for completion of existing project	90,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1897	70,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Comparative statement of lumber, laths, shingles, pickets, and logs for seventeen years.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total tonnage, exclusive of loose logs.	Loose logs.
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet, B. M.*
1878	154,119,860	40,000,000	125,000,000	10,000,000	.....	Unknown
1879	248,932,000	62,044,000	135,152,000	12,000,000	.....	250,000,000
1880	325,150,000	100,357,750	74,945,150	2,423,940	.....	300,000,000
1881	342,887,000	64,787,000	121,437,000	1,880,000	.....	300,000,000
1882	375,000,000	66,000,000	150,000,000	2,200,000	.....	350,000,000
1883	269,094,203	82,643,500	129,754,000	1,497,948	.....	450,000,000
1884	298,344,591	88,905,520	160,133,000	1,840,278	.....	534,674,178
1885	374,138,443	95,992,900	195,880,220	75,000,000	.....	600,000,000
1886	207,205,672	77,729,630	158,465,750	1,934,340	.....	465,000,000
1887	186,826,521	64,725,580	130,516,200	3,023,235	.....	404,302,650
1888	161,309,512	50,544,370	86,348,900	1,500,320	325,971	542,437,000
1889	158,938,294	50,487,355	112,053,075	2,244,786	329,156	400,518,720
1890	166,477,966	46,234,673	78,499,500	1,222,989	342,350	606,992,790
1891	152,040,386	107,841,850	48,700,210	1,258,850	314,085	284,113,430
1892	144,651,150	46,451,170	109,356,000	1,507,050	410,980	632,350,670
1893	159,180,534	43,938,210	108,774,500	1,940,525	459,505	488,926,000
1894	128,703,908	33,550,370	74,183,250	1,420,618	333,157	250,045,730

Comparative statement of freight and passengers for seventeen years.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
		Pounds.				*Pounds.*	
1878	4	Unknown.	Unknown.	1887	1	600,000	1,400
1879	4	6,840,000	8,730	1888	*1		
1880	4	3,440,000	11,240	1889	*1		
1881	3	3,932,000	16,989	1890	*1		
1882	3	2,640,000	10,490	1891	*1		
1883	3	3,184,000	4,000	1892	*1		
1884	2	1,500,000	5,500	1893	*1		
1885	1	690,000	4,728	1894	*1		
1886	1		4,700				

* One hundred and eight tons burden and 2 feet draft.

But one steamboat plied regularly on the river during the past seven seasons. This boat, the *Phil Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about half way between the mouth and Eau Claire to assist the Knapp, Stout & Co. Company's rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

Y 5.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The project and original estimate for the improvement of this river were submitted by Major Farquhar in a report dated January 30, 1875 (pp. 373–375, Part I, Annual Report, 1875), upon the results of a survey made in 1874 when the St. Croix was at a high stage of water, and but comparatively few bars or other obstructions to be seen, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand bars between Taylor Falls and Prescott, and construction of low-water channel between Taylor Falls and Stillwater into one of nearly uniform width, by means of brush and stone jetties and dams of the same material, to close island chutes and secondary channels. Estimated cost, $21,758.

In 1879 Major Allen made a low-water survey of the river, submitting his report January 26, 1880. In this report, printed on pages 1661–1668, Part II, Annual Report, 1880, he estimated the cost to complete improvements at $60,250, making a total of $78,250 from time of commencement in 1878.

The estimate was revised in 1882 and again in 1889. (See p. 1801, Annual Report, 1889.) The last revision placed the cost at $34,200 to complete, or a total of $129,700 for the whole improvement.

The lower part of the river is known as Lake St. Croix. Stillwater, at the head of the lake, divides the navigable portion of the river into two sections, the upper or river section, 28½ miles in length, and the lower or lake section, 23.8 miles in length.

In the Annual Report of 1889 my predecessor reported:

> The first appropriation for the improvement of the St. Croix was $10,000, made by act of Congress approved June 18, 1878.
>
> At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The low-water channel had in many places but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places. Under this appropriation some of the worst obstructions were removed between Taylor Falls and Stillwater.

The free navigation of the lower section was obstructed by partly sunken logs and by the Hudson and Catfish bars, 6.3 and 15.1 miles,

respectively, below Stillwater. The channel over the Hudson Bar was quite tortuous and shallow, having but 2½ feet depth at low water. At Catfish the channel had sufficient depth, but made a sharp bend around a long, narrow sand spit that jutted out for a distance of 1,450 feet from the left bank and at right angles to the shore line. When a strong wind blew up or down the lake, the steamboat with heavy rafts encountered considerable difficulty in keeping the channel.

The improvements to June 30, 1891, resulted in a decidedly improved channel above Stillwater to the advantage of the river traffic then existing. The improvements consisted in the removal of sunken cribs, wrecks, snags, old boom piers, and leaning trees, and the construction of wing dams to contract the channel over the worst bars, and thereby increased the depth over the bars worked on from an original low-water depth of 2 to 3 feet.

Since 1886 the railroads penetrating the region have reduced navigation over this section to almost nothing, except the running of loose logs; as a consequence, little attention during the past six years has been given to its improvement.

On the lower section (Stillwater to the mouth) the commerce, consisting of rafted lumber and logs towed by steamboats, is of large proportions and its needs are being met by expending the largest part of appropriations on this reach. By June 30, 1894, channels had been dredged through the Catfish and Hudson bars to a depth of 4 feet at low water and the water directed into new channels by training dams.

Many of the partly submerged logs were also removed, but new ones are continually coming into the channel. The work has resulted in creating a fair steamboat channel, 4 feet deep at low water, from Stillwater to the mouth. Boats and rafts can now pass over that distance at the lowest stage, but some work remains to be done in widening the dredged channels and straightening other portions, particularly on the Hudson Bar above and below the bridge.

Amount expended to June 30, 1894, including outstanding liabilities, $108,500.

OPERATIONS DURING THE PAST FISCAL YEAR.

Work was confined to dredging in the channel over the Hudson Bar. Total amount of excavation, 8,843 cubic yards. The work at Hudson Bar has facilitated the passage of raft boats with their large tows.

Total expended during the fiscal year ending June 30, 1895, including outstanding liabilities, $2,566.43.

Total of work done since the commencement of operations in 1878.

Snags removed	number..	4,091
Leaning trees removed	do....	6,344
Stumps removed	do....	2,722
Piles removed	do....	32
Cribs or piers removed	do....	44
Wrecks removed	do....	3
Logs removed	do....	718
Clay and gravel removed above Stillwater	cubic yards..	146
Bowlders removed	do....	636.5
Shore protection and revetment built of brush and stone	linear feet..	6,332
Dams and jetties built of brush and stone	do....	9,388
Training walls at Hudson, built of piles, timber, brush, and stone	do....	2,965
Scraping channel through Hudson Bar	cubic yards..	8,694
Scraping channel through Catfish Bar	do....	14,000
Dredging at head of lake, Hudson and Catfish bars	do....	71,317
Pier logs removed	number..	20
Drift piles removed	do....	2
Log jams broken	do....	1

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1894, $247,454.02; value of domestic exports for same period, $222,203.

Abstract of appropriations.

By act—		By act—	
Approved June 18, 1878.....	$10,000	Of August 11, 1888.....	$10,000
Approved March 3, 1879....	8,000	Approved September 19, 1890	8,000
Approved June 14, 1880.....	10,000	Approved July 13, 1892.....	8,000
Approved March 3, 1881....	8,000	Of August 17, 1894.....	4,000
Passed August 2, 1882.....	30,000		
Approved July 5, 1884.....	9,000	Total	112,500
Approved August 5, 1886....	7,500		

Money statement.

July 1, 1894, balance unexpended.....	$5.59
Amount appropriated by act of August 17, 1894.....	4,000.00
	4,005.59
June 30, 1895, amount expended during fiscal year.....	620.89
July 1, 1895, balance unexpended.....	3,384.70
July 1, 1895, outstanding liabilities.....	1,951.13
July 1, 1895, balance available.....	1,433.57
Amount (estimated) required for completion of existing project.....	14,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	14,200.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Comparative statement of steamboats and barges, freight and passengers carried, lumber and logs towed and rafted, on the St. Croix River, Wisconsin and Minnesota, for a period of seventeen years.

STEAMBOATS AND BARGES.

Year.	In freight and passenger business.		Steamboats in towing and rafting business.	Year.	In freight and passenger business.		Steamboats in towing and rafting business.
	Steamboats.	Barges.			Steamboats.	Barges.	
1878*	3	.....	8	1887	3	40	58
1879	3	.....	12	1888	1	3	58
1880	3	.....	29	1889	1	1	52
1881	2	.....	40	1890	2	3	126
1882	3	24	77	1891	†1	0	‡130
1883	3	25	51	1892	0	0	‡122
1884	3	25	30	1893	0	0	‡127
1885	4	33	50	1894	1	2	‡69
1886	6	38	49				

* Amount of commerce and navigation when work of improvement began.
† 117 tons burden and 18 inches draft.
‡ From 35 to 240 tons burden and 2½ to 3½ feet draft.

Comparative statement of steamboats and barges, etc.—Continued.

FREIGHT AND PASSENGERS.

Year.	Freight carried.				Passengers carried.
	General merchandise.	Lumber.	Wood.	Total.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
1878*	Unknown.	Unknown.	Unknown.	16,000	15,000
1879	Unknown.	Unknown.	Unknown.	23,893	9,244
1880	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
1881	Unknown.	Unknown.	Unknown.	17,500	11,015
1882	Unknown.	Unknown.	Unknown.	30,000	10,300
1883	Unknown.	Unknown.	Unknown.	31,500	12,800
1884	Unknown.	Unknown.	Unknown.	40,000	4,000
1885	Unknown.	Unknown.	Unknown.	42,500	10,647
1886	Unknown.	Unknown.	Unknown.	90,450	12,756
1887	Unknown.	Unknown.	Unknown.	28,500	9,872
1888	Unknown.	5,200	4,354	90,554	Unknown.
1889	Unknown.	5,900	4,100	10,000	Unknown.
1890	209	7,139	5,796	13,144	921
1891	Unknown.	100	200	300	551
1894	None.	3,205	None.	3,205	None.

*Amount of commerce and navigation when work of improvement began.

RAFTED LOGS AND LUMBER.

Year.	Rafted logs towed out of St. Croix River (estimated).	Rafted lumber towed out of St. Croix River.				Total tonnage exclusive of loose logs.	Loose logs run on river above Stillwater.	
		Lumber.	Shingles.	Laths.	Pickets.			
	Feet, B. M.	*Feet, B. M.*	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet, B. M.*	*Tons.*
1878	70,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1879	117,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1880	200,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1881	185,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1882	130,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1883	108,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1884	175,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1885	150,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1886	115,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1887	175,000,000	100,000,000	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
1888	136,000,000	114,610,966	40,079,500	23,651,800	570,820	706,367	Unknown	Unknown
1889	150,000,000	81,817,070	38,633,000	23,226,575	90,800	697,244	Unknown	Unknown
1890	250,000,000	116,403,000	46,007,000	33,861,900	278,580	1,104,100	460,000,000	1,610,000
1891	209,233,490	110,934,084	32,016,750	31,132,350	678,240	948,757	315,231,300	1,103,310
1892	250,000,000	126,503,520	51,959,000	37,387,200	261,040	1,179,549	436,899,770	1,529,149
1893	160,000,000	63,564,209	23,196,500	18,413,720	118,580	707,745	359,468,740	1,358,141
1894	150,000,000	105,912,803	38,861,250	28,385,600	1,059,420	805,838	281,470,400	985,146

Y 6.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Major Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of the Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the Report of the Chief of Engineers for the fiscal year ending June 30, 1873.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of Minnesota River."

A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles to determine the practicability of improving navigation by means of canals, locks, and dams. The results of this survey proved the possibility of a lock-and-dam navigation for the distance passed over.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River, with a view to its improvement by locks and dams. The survey, extended from the mouth of the river to Mankato, was made by my predecessor during the season of 1887, and a report thereon, with maps, rendered January 16, 1888. This report was printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

The following are the projects and estimates which have been submitted:

Original estimate, Annual Report, 1867—	
(1) Open-channel improvement, Yellow Medicine to the mouth, 237 miles	$117,000
(2) Slack water (locks and dams in river), Yellow Medicine to the mouth, 237 miles	775,500

The channel plan (1) was approved by Congress in appropriating $37,500 (March 2, 1867) for "removing snags and bowlders."

Revision No. 1 (see p. 364, Part I, Annual Report, 1875):	
Slack water (locks and dams in river), South Bend to mouth, 116.4 miles	$733,868.63
Amounts previously appropriated	87,500.00
Total	821,368.63

In addition to the above, the following estimates relating to the improvement of the Minnesota River have been made, but were not considered as having been accepted for a project:

By Maj. G. K. Warren (see p. 414, Part I, Annual Report, 1875):	
Canal from north end Lac Travers to mouth of Minnesota River, distance by river, 398.13 miles; by canal, 281 miles	$12,560,000
By Colonel Macomb (see p. 439, Annual Report, 1873):	
Open-channel improvement, Minnesota Falls to mouth of Yellow Medicine, 4.65 miles	2,925
By Maj. C. J. Allen (see p. 1580, Part III, Annual Report, 1888):	
Slack water (locks and dams in river), South Bend to the mouth, 116.4 miles	1,883,968

The appropriations up to and including that of June 18, 1878, were applied to surveys and in removing snags, bowlders, etc., on the upper part of the river, between Minnesota Falls and a point 30 miles below Henderson (16.7 miles above Shakopee). The rapidly caving banks on this stretch of the river add snags and leaning trees to the channel yearly, so that channels that were cleared thirteen years ago are encumbered with them to-day.

By the river and harbor act of August 11, 1888, Congress appropriated for—

Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, $10,000.

The river and harbor act approved July 13, 1892, made the sum appropriated by act of August 11, 1888, "available for the improvement of the river, omitting the requirement for operations at Belle Plaine."

Previous to the fall of 1893 no money had been spent on the lower part of the river, which presents a marked contrast to the upper section.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered permanent by the improvement at the mouth of the river.

In the fall of 1893 a project was carried into effect for the improvement of the river below Chaska and Shakopee by building a closing dam at the foot of Pike Island and across the main channel at the mouth of the river and diverting the river during low stages through a channel dredged through the Fort Snelling Chute. For a fuller description of the plan of improvement see pages 1726, 1727, Annual Report, 1894.

After the completion of the dam and opening of the new channel soundings made up the Minnesota River gave the following depths at mean low water:

	Feet.
Up to Shakopee (24.2 miles)	6+
Up to Chaska (28.6 miles)	5
Up to lower end of Carver	4½
At Carver Bridge (31 miles)	2

At extreme low water the depths would be about 1 foot less than those given above.

It will be observed that the improvement gave a navigable channel, to the lower end of the town of Carver, though the project contemplated a channel to Chaska only.

During the high water of the following spring a deposit took place in the Mississippi end of the Fort Snelling cut and blocked the entrance to the cut and the river at low stages. The deposit was caused mainly by a rise in the Mississippi River without an appreciable natural rise in the Minnesota, supplemented by the fact that the dam was not of sufficient height to keep out the Mississippi waters.

The material forming the deposit came largely from an old bar just above the end of the cut. It was expected to have removed this bar, but the funds available were not sufficient.

Amount expended to June 30, 1894, including outstanding liabilities, $126,926.

WORK DURING THE PAST FISCAL YEAR.

During the month of June, 1895, minor repairs were made to the dam at the mouth of the river and a temporory channel was excavated through the deposit in Fort Snelling Chute.

Amount expended during the fiscal year ending June 30, 1895, including outstanding liabilities, $574.

An appropriation of $15,000 is needed to complete the improvement at mouth of river.

Abstract of appropriations.

By act—		By act—	
Approved March 3, 1867	$37,500	Approved March 3, 1875	$10,000
Approved July 11, 1870	10,000	Approved August 14, 1876	10,000
Approved March 3, 1871	10,000	Approved June 18, 1878	10,000
Approved June 10, 1872	10,000	Of August 11, 1888	10,000
Passed March 3, 1873	10,000		
Approved June 23, 1874	10,000	Total	127,500

Money statement.

July 1, 1894, balance unexpended	$590.50
June 30, 1895, amount expended during fiscal year	98.63
July 1, 1895, balance unexpended	491.87
July 1, 1895, outstanding liabilities	491.87
Amount (estimated) required for completion of existing project	693,868.63
Amount that can be profitably expended in fiscal year ending June 30, 1897	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Year.	Steamboats plying on lower part of river.			Freight carried.					
	No.	Tonnage.	Draft.	Wheat.	Hay.	Wood.	Brick.	Miscellaneous.	Total.
		Tons.	*Inches.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1888	1								3,350
1889	2	153	18						4,900
		180	20						
1890	3	117	18	62	809	840	1,080	842½	3,633½
		153	30						
		180	20						

There was no traffic on the river during the seasons of 1891, 1892, 1893, and 1894, as steamboats could not pass the bar at the mouth of the river.

Y 7.

IMPROVEMENT OF THE RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

The project for improvement of this river from Breckenridge to the northern boundary line, adopted in 1877, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars, except at Goose Rapids, where a lock and dam was proposed. The estimated cost was:

For the open-channel improvement, exclusive of Goose Rapids	$145,310.18
For lock and dam, Goose Rapids	219,287.99
Total	364,598.17

In 1883 the cost of the open-channel improvement, exclusive of Goose Rapids, was revised and placed at $179,310.18.

Until August 5, 1886, the improvement of the river, exclusive of Goose Rapids, and the improvement of Goose Rapids were considered as separate works.

In 1886–87 they were consolidated into one, and the project for the improvement of the river was modified by substituting the open-channel methods (removal of bowlders and dredging) over Goose Rapids for the proposed lock and dam. In 1887 the cost of completing the improvement was estimated at $79,598.37, making the total cost of the improvement from commencement of work $249,598.37. In 1893 this was increased to $67,320 for completion, or $307,320 for total cost from commencement of work.

One skiff, repaired, calked, and painted. Cost of repairs, $31.41.

Ten thousand eight hundred and eighty-two feet, B. M., of pine lumber, 882 feet, B. M., of oak lumber, 800 pounds of boat spike, and 11½ bales of oakum were used in the work. The repairs were made as thorough and complete as possible; some of the boats are, however, getting quite old, having been in service from eight to thirteen years, and the limit of possible repair in some cases has now been reached; this is particularly so in the case of the dredge *Otter Tail*, built and first operated in 1882. The repairs now made on the hull and superstructure of this dredge, it is estimated, will render it serviceable for two seasons' dredging. After that, however, entire reconstruction will be absolutely necessary. The machinery of the dredge *Otter Tail* is in good condition, and with the usual renewal of the wearing parts will easily outlast another hull.

Season of 1895 to June 30.—The inspecting officer having examined and condemned the hulls of the boats remaining unrepaired at the close of the season's operations in 1894, and ordered them destroyed, this work was commenced January 3 and closed February 25.

The hulls condemned were those of the dredge *Unser Fritz*, built in 1879, steamer *General Poe* and the derrick boat, built in 1882, and two wood barges and three skiffs, built in 1879–1882. The machinery of the dredge, steamboat, and derrick boat was removed and stored in good and servicable condition, and will be available for future use.

Forty-three cords of mixed wood, oak and pine, worth $2 per cord, were saved from the old hulls, several spuds and other timbers, some planking, flooring, etc., and a lot of iron bolts and boat spike were also saved, all of which will be of value for future repairs on the dredging fleet.

The cost of demolition of the hulls and the removal of the machinery was $539.12; deducting the value of the wood saved for fuel, used by the dredge and steamboat on the work this spring, the net cost was $453.12.

The preparatory work this year for the continuation of the improvement of the river by dredging was commenced April 15. Owing to the repairs made on the boats last fall this preparatory work consisted only of the arrangement of the machinery of the steamboat and dredge for active operations.

Dredging was commenced April 27 at a point 11 miles north of Grand Forks, and to this date, June 30, 44 miles of river have been worked over.

Total excavation, 18,695 cubic yards. Length of channel cuttings, 8,225 linear feet. Length of wing and training dams formed with the excavated material, 8,305 linear feet.

Average cost of excavation per cubic yard, 17½ cents. Cost of subsistence per ration, 38¼ cents.

The steamer *Ogama* operated in connection with the dredge, towing the fleet, keeping up the supply of fuel, etc., made 23 trips. Total miles run, 977. Wood loaded and conveyed to the dredge, 121½ cords. The cost of maintaining and operating the steamboat is included in the cost of the work.

The improvement of the river so far this season has been entirely of the nature of repair work on the old channel cuttings, as the section of river worked over had been previously dredged to the standard depth. In places now, however, the dredged channels have been partially filled up, rendering more or less redredging at some points absolutely necessary to permit navigation at low water.

A feature of the filling up of these previously dredged channels is the fact that it does not come to any noticeable extent from the deposit of the usual river silt, etc., but appears to be caused entirely by the settling of the adjacent high lands always on the concave side of the bends. As the bank settles, as a rule vertically, the bottom of the river in the immediate vicinity appears to be forced upward, neutralizing, of course, to a greater or less extent, the channel excavations previously made.

These movements of the bank and river bottom are, as a rule, very gradual, the yearly change being generally barely noticeable; in some localities the movements, however, appear to be constant.

The depth of excavation necessary to get the channel again in shape has so far averaged about 2 feet. On examination the condition of partially filled channels was found to extend over a section of river between points 11 miles and 58 miles north of Grand Forks. In the 47 miles, 15 places were found where more dredging was required. On the remainder of the river examined, from 35 miles south to 100 miles north of Grand Forks, the dredged channels were found to be unchanged.

All of the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1895, including outstanding liabilities, $10,192.20.

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Approved August 5, 1886	$50,000
Approved June 18, 1878	30,000	Of August 11, 1888	20,000
Approved March 3, 1879	25,000	Approved Sept. 19, 1890	25,000
Approved June 14, 1880	20,000	Approved July 13, 1892	25,000
Approved March 3, 1881	18,000	Of August 17, 1894	15,000
Passed August 2, 1882	10,000		
Approved July 5, 1884	10,000	Total	255,000

Money statement.

July 1, 1894, balance unexpended	$353.06
Amount appropriated by act of August 17, 1894	15,000.00
	15,353.06
June 30, 1895, amount expended during fiscal year	9,148.77
July 1, 1895, balance unexpended	6,204.29
July 1, 1895, outstanding liabilities	1,294.19
July 1, 1895, balance available	4,910.10
Amount (estimated) required for completion of existing project	52,320.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	52,320.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

GRAND FORKS, N. DAK., *June 30, 1895.*

MAJOR: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1895, is respectfully submitted:

The work done during the last half of the season of 1894 was confined entirely to repairs on the dredging fleet. As the hulls of all of the boats were more or less decayed and unseaworthy, the most important boats having been in service from eight to fifteen years, those in the best condition were selected for repair in number sufficient for one complete dredging outfit.

In all eight boats were overhauled (steamer *Ogama*, dredge *Otter Tail*, one quarter boat, one slide scow, and four wood barges), one skiff was also repaired, at a total cost for labor and material, including the preparation of the boat yard and the setting of the ways, of $2,453.53.

The repairs were commenced September 5 and closed November 18. The work in detail, with cost of repairs on each boat, was as follows:

Steamer *Ogama*, bottom and sides of hull repaired with oak, new hog-chain posts put in, forecastle deck replaced and calked, new rudder posts constructed, new flanges placed on wheel and wheel repaired, smokestack and breeching repaired, and entire hull calked and painted; cost of repairs, $693.35.

Dredge *Otter Tail*, new gallows frame constructed, "A" braces repaired and strengthened with oak, complete new deck laid and calked, sides and bottom of hull partially replanked, five sets of hog chains made and placed in position, and entire hull calked and painted; cost of repairs, $837.49.

Quarter boat, new outside planking on sides and rakes of hull, new deck and partial new frame at both ends, and hull calked and painted; cost of repairs, $199.24.

Slide scow, outside planking and frame repaired and hull calked and painted; cost of repairs, $110.89.

Four wood barges, sides and bottoms repaired and partially replanked and hulls calked and painted. Cost of repairs, $580.95.

Comparative statement of freight moved by steamboats and barges during the past sixteen years.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1894	7,684	1888	12,140	1883	25,314
1893	5,723	1887	10,405	1882	31,652
1892	14,256	1886	10,507	1881	26,557
1891	12,137	1885	23,045	1880	21,651
1890	1,710	1884	29,046	1879	17,829
1889	8,866				

Y 8.

GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

The Board of Engineers, to whom was referred the project for the application of $37,500 appropriated by the river and harbor act of August 5, 1886, for reservoirs at the head waters of the Mississippi River, recommended in their report, dated May 24, 1887, "that such gaugings be made at or near St. Paul during the annual operation of the reservoirs as shall determine accurately the discharge at that point during critical periods" (p. 1692, Annual Report, Chief of Engineers, 1887).

The river and harbor act of August 11, 1888, authorized the gaugings and provided for them as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during annual operations of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

* * * * * * *

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however*, That an itemized statement of said expense shall accompany the Annual Report of the Chief of Engineers.

Gaugings were not made until the fall of 1889, although an allotment for $900 for the fiscal year ending June 30, 1889, had been made.

On account of the lateness of the season and the condition of the river it was not deemed advisable to expend any of the money that year.

For the purpose of preserving a concise record of the volume of the Mississippi River at St. Paul, all gaugings made at that point by this office are included in the list below:

Table of gaugings made at St. Paul, Minn., during the fiscal year ending June 30, 1895.

[Location: Robert Street Bridge. Method: Ellis current meter No. 18.]

OPEN RIVER.

No.	Date.	Reading of Signal Service guage, St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1894.		*Cubic feet.*			1894.		*Cubic feet.*	
1	July 2	2.70	5,323	Breeze down.	57	Sept. 12	1.45	3,674	Strong breeze down.
2	July 3	2.60	5,420		58	Sept. 13	1.6	3,849	
3	July 6	2.30	4,922		59	Sept. 18	1.81	4,169	
4	July 7	2.10	4,573		60	Sept. 19	1.61	4,002	Wind down.
5	July 9	1.90	4,367		61	Sept. 20	1.6	3,868	
6	July 11	1.99	4,287	Breeze up.	62	Sept. 21	1.51	3,811	
7	July 12	1.99	4,449		63	Sept. 22	1.55	3,663	
8	July 13	1.82	4,176		64	Sept. 24	1.62	4,317	Do.
9	July 14	1.69	3,988		65	Sept. 26	1.65	3,906	Do.
10	July 16	1.40	3,426		66	Sept. 27	1.48	3,919	
11	July 17	1.40	3,489		67	Sept. 28	1.515	3,807	
12	July 18	1.35	3,306		68	Oct. 1	1.71	4,425	Do.
13	July 19	1.40	3,454		69	Oct. 2	2.00	4,670	Do.
14	July 20	1.50	3,732		70	Oct. 3	1.9	4,463	
15	July 21	1.25	3,296		71	Oct. 4	2.00	4,794	
16	July 23	1.12	3,397	River rising.	72	Oct. 6	2.05	4,589	
17	July 24	1.30	3,887	Do.	73	Oct. 8	2.075	5,297	Do.
18	July 25	1.1	3,072		74	Oct. 9	2.00	4,580	
19	July 26	.85	2,740		75	Oct. 10	2.00	4,570	
20	July 27	.85	2,633		76	Oct. 11	2.1	4,798	
21	July 28	.58	2,367		77	Oct. 12	2.25	5,047	
22	July 30	.85	2,267		78	Oct. 13	2.09	4,978	
23	Aug. 1	.38	2,081		79	Oct. 15	1.9	4,569	
24	Aug. 2	.31	2,144		80	Oct. 16	1.78	4,185	
25	Aug. 3	.28	1,984		81	Oct. 17	1.78	4,195	
26	Aug. 4	.55	2,449	Do.	82	Oct. 18	1.50	3,759	
27	Aug. 7	.40	2,497		83	Oct. 20	1.69	4,245	Do.
28	Aug. 8	.48	2,128		84	Oct. 22	1.7	4,799	
29	Aug. 9	.25	1,962		85	Oct. 23	1.81	4,377	
30	Aug. 10	.55	2,456		86	Oct. 24	1.55	4,021	
31	Aug. 11	1.2	3,278		87	Oct. 25	1.825	4,513	
32	Aug. 13	1.7	4,419		88	Oct. 26	1.65	4,111	Rising.
33	Aug. 14	1.8	4,333		89	Oct. 27	1.52	4,044	
34	Aug. 15	1.7	4,286		90	Oct. 30	1.97	4,729	
35	Aug. 16	1.81	4,402		91	Oct. 31	2.05	4,902	
36	Aug. 17	1.66	4,035		92	Nov. 1	2.1	4,980	
37	Aug. 18	1.45	3,709		93	Nov. 7	2.21	5,355	
38	Aug. 20	1.82	4,319		94	Nov. 8	2.16	5,158	
39	Aug. 21	1.8	4,469		95	Nov. 9	2.11	5,204	
40	Aug. 22	1.82	4,297		96	Nov. 10	2.1	5,064	
41	Aug. 23	1.86	4,440		97	Nov. 12	1.62	4,558	
42	Aug. 24	1.885	4,640		98	Nov. 13	1.83	4,591	
43	Aug. 25	1.88	4,266		99	Nov. 14	1.93	4,489	
44	Aug. 27	1.78	4,465		100	Nov. 15	2	4,775	
45	Aug. 28	1.9	4,387		101	Nov. 16	1.82	4,748	
46	Aug. 29	1.5	3,747		102	Dec. 10	.92	3,422	
47	Aug. 30	1.625	3,957		103	Dec. 11	.85	2,974	
48	Aug. 31	1.65	3,949		104	Dec. 12	.825	2,960	
49	Sept. 1	1.59	3,851		105	Dec. 13	.825	2,810	
50	Sept. 4	1.6	3,997		106	Dec. 14	.82	2,828	
51	Sept. 5	1.5	3,696		107	Dec. 18	.85	2,829	
52	Sept. 6	1.5	3,815	Breeze up.	108	Dec. 19	.82	2,836	
53	Sept. 7	1.61	4,013		109	Dec. 20	.82	2,907	
54	Sept. 8	1.7	3,967		110	Dec. 21	.82	3,038	Wind down.
55	Sept. 10	1.65	4,258	Strong breeze down.	111	Dec. 24	.62	2,586	
56	Sept. 11	1.75	3,994						

Table of gaugings made at St. Paul, Minn., etc.—Continued.

[Location: Robert Street Bridge. Method: Ellis current meter No. 18.]

RIVER FROZEN.

No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1895.					1895.			
112	Jan. 3	.85	1,755		125	Jan. 23	.9	1,336	
113	Jan. 4	.8	1,708		126	Jan. 24	.9	1,397	
114	Jan. 7	.85	1,624		127	Jan. 25	.9	1,381	
115	Jan. 8	.85	1,590		128	Jan. 28	.9	1,442	
116	Jan. 9	.8	1,556		129	Jan. 29	1.03	1,518	
117	Jan. 10	.715	1,309		130	Jan. 30	.8	1,250	
118	Jan. 12	.85	1,526		131	Feb. 4	.715	1,056	
119	Jan. 14	1.00	1,646		132	Feb. 5	1.05	1,324	
120	Jan. 15	1.06	1,714		133	Feb. 6	1.085	1,300	
121	Jan. 17	1.00	1,608		134	Feb. 11	.825	*1,223	
122	Jan. 19	1.085	1,504		135	Feb. 12	1.00	*1,372	
123	Jan. 21	1.1	1,586		136	Feb. 13	1.00	*1,464	
124	Jan. 22	1.15	1,552		137	Feb. 14	.95	*1,361	

*Herschel meter No. 13.

OPEN RIVER.

[Method: Price current meter No. 1.]

138	Apr. 2	1.09	3,476	Wind up.	142	Apr. 6	.95	3,510	Wind up.
139	Apr. 3	.99	3,539		143	Apr. 8	.90	3,363	Do.
140	Apr. 4	.95	3,335		144	Apr. 10	.79	3,269	
141	Apr. 5	1.0	3,601						

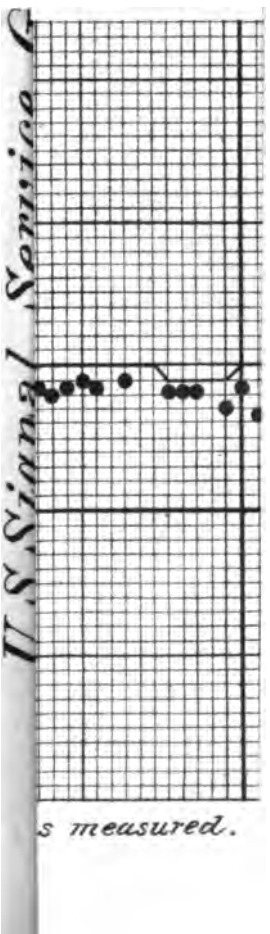
[Method: Ellis current meter No. 21.]

145	Apr. 11	1.01	3,945		170	May 13	2.4	5,854	River rising.
146	Apr. 13	1.00	3,460	Gusty wind up.	171	May 14	2.16	5,327	
147	Apr. 15	.9	3,602		172	May 15	1.99	5,188	
148	Apr. 16	.85	3,515		173	May 16	2.19	5,231	River falling.
149	Apr. 17	.8	3,389		174	May 17	2.00	5,040	
150	Apr. 18	.825	3,348		175	May 18	1.96	5,122	
151	Apr. 19	.85	3,445	Rising, wind down.	176	May 20	1.5	4,682	
					177	May 23	1.5	*4,733	Gale down.
152	Apr. 20	.81	3,430	Wind down.	178	May 29	1.74	*4,405	Wind down.
153	Apr. 22	.81	3,531	Do.	179	May 31	1.74	*4,667	
154	Apr. 23	.9	3,481		180	June 1	1.8	*4,944	
155	Apr. 24	.45	2,867		181	June 6	3.00	*6,731	
156	Apr. 25	.45	2,886	Wind up.	182	June 12	4.05	†8,029	
157	Apr. 26	.75	3,311		183	June 14	4.4	‡9,138	
158	Apr. 27	.85	3,502		184	June 15	4.52	‡9,901	
159	Apr. 29	1.025	4,000		185	June 17	4.52	‡9,537	
160	Apr. 30	.875	3,458	Wind up.	186	June 18	4.42	‡8,900	
161	May 1	.69	3,184		187	June 19	4.225	‡8,904	
162	May 2	.77	3,419		188	June 20	4.00	‡8,207	
163	May 3	.925	3,590		189	June 21	3.78	‡7,919	
164	May 4	1.15	3,936	Wind down.	190	June 22	3.528	‡7,560	
165	May 6	1.55	4,797		191	June 24	3.425	‡7,592	
166	May 7	1.9	5,134		192	June 25	3.375	‡6,986	
167	May 8	1.925	4,946		193	June 26	3.35	‡7,100	
168	May 9	2.11	5,267	River rising.	194	June 27	3.35	‡7,062	
169	May 11	2.54	6,107	Wind down; river falling.	195	June 28	3.48	‡6,975	
					196	June 29	3.6	‡7,675	

*Price meter No. 1. †Herschel meter No. 12. ‡Herschel meter No. 13.

The gaugings were made by observing the mid-depth velocities in sections 20 feet apart. In open sections the mean velocity was taken as 95 per cent, and in sections closed by ice* as 87½ per cent of the mid-depth velocity.

*See page 2104, Annual Report, Chief of Engineers, 1890.


U.S. Signal Service
s measured.

The results of the gaugings are interesting and valuable, so far as they go, but I desire to repeat the recommendation contained in previous annual reports that the money heretofore allotted and made available for gauging has been inadequate to procure the information needed for a correct and scientific investigation of the effect of the reservoir water on the Mississippi River. It is imperative that this effect shall be ascertained and established beyond question. The knowledge gained would be of use not only in connection with the present reservoir system at the head waters of the Mississippi River, but also in determining the value of reservoirs as a means of improving rivers in general.

It is recommended that Congress be asked to fix the amount to be annually available for this specific work and to extend the area within which gaugings may be made so as to include the Mississippi River and its tributaries between St. Paul, Minn., and the reservoirs at head waters of the Mississippi River.

Amount expended during the fiscal year ending June 30, 1895, $500.

Abstract of allotments.

For fiscal year ending June 30,—		For fiscal year ending June 30,—	
1889	*$900.00	1893	$500.00
1890	600.00	1894	500.00
1891	900.00	1895	500.00
1892	900.00	1896	500.00

Money statement.

July 1, 1894, balance unexpended	$21.93
Amount allotted for fiscal year ending June 30, 1895	500.00
	521.93
June 30, 1895, amount expended during fiscal year	521.93
Amount allotted for fiscal year ending June 30, 1896	500.00

Itemized statement of expenditures during the fiscal year ending June 30, 1895.

Date.	To whom paid.	For what paid.	Amount.
1894.			
Aug. 31	Sundry persons	Pay roll for August, 1894	$185.00
Oct. 1	....do	Pay roll for September, 1894	185.00
Oct. 6	P. Pederson	Repair work	1.00
Oct. 31	Sundry persons	Pay roll for October, 1894	110.00
1895.			
Jan. 3	Miles & Hale	Okanite	1.40
Jan. 24	Minnesota Engine Works	Repair work	2.35
Mar. 13	Joseph Rothwell	Ice chisel	2.00
Mar. 22	F. C. Messing	Rubber stamps	2.85
Mar. 26	American Express Co	Express charges	1.25
Mar. 26	Buff & Berger	Agates	8.59
Mar. 26	St. Paul Hardware Co	Hardware	.56
	Total		500.00

*Not used.

Y 9.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys reference is made to pages 1507 and 1508, Appendix Y, Part II, Annual Report of Chief of Engineers, 1886.

It has been demonstrated that the reservoir system at the sources of the Mississippi River increases the navigable capacity of the Mississippi River at St. Paul at least 1 foot during low-water seasons. It is simply a question of more or less water collected as to whether the improvement shall be more or less than that. More water must of necessity improve a river for navigable purposes, and hence I think it advisable to see whether the great collecting capacity of the watershed of the Crow Wing River can not be added to the present supply at a reasonable cost. It is therefore recommended that the sum of $5,000 be expended in making an examination and survey of the basin of Crow Wing River, with a view to determine whether its waters can be added to the reservoir system at a reasonable cost.

It is to be particularly noted that although the steamboat navigation above Minneapolis is at present insignificant, the time is pretty sure to come when it will be important; and, furthermore, there is to-day an enormous commerce upon these waters. The great mass of floating logs is nothing more or less than a commercial product being moved to market by the cheapest known form of transportation. The actual annual tonnage of products of the forest thus moved to market is considerably in excess of 1,000,000 tons, and the tonnage is rapidly increasing.

This is a commerce worthy of attention and consideration.

Money statement.

Amount (estimated) required for completion of existing project.....	$50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Y 10.

PRELIMINARY EXAMINATION OF MINNESOTA RIVER, MINNESOTA, WITH A VIEW TO PROTECTING THE BANKS OPPOSITE THE BOROUGH OF BELLE PLAINE SO AS TO PREVENT THE RIVER FROM CUTTING THROUGH THE NARROW NECK OF LAND AT THAT POINT, AND WITH A VIEW OF PROTECTING THE BANKS AT AND NEAR THE CITY OF MANKATO.

[Printed in House Ex. Doc. No. 271, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 28, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 15, 1895, by Maj. W. A. Jones, Corps of Engineers, of the results of preliminary examination of "Minnesota River, with a view

to protecting the banks opposite the borough of Belle Plaine so as to prevent the river from cutting through the narrow neck of land at that point, and with a view of protecting the banks at and near the city of Mankato," made to comply with provisions of the river and harbor act of August 17, 1894.

It is the opinion of Major Jones, concurred in by Col. O. M. Poe, Corps of Engineers, division engineer, and by this office, that the localities are not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 15, 1895.

GENERAL: In compliance with instructions contained in Department letter of August 20, 1894, I have the honor to submit report of a preliminary examination of "Minnesota River, with a view to protecting the banks opposite the borough of Belle Plaine so as to prevent the river from cutting through the narrow neck of land at that point, and with a view to protecting the banks at and near the city of Mankato."

BELLE PLAINE.

This is the third time Congress has called for a preliminary examination of this locality. For a full description of the local conditions attention is invited to reports of Maj. C. J. Allen, Corps of Engineers, published in Annual Report, Chief of Engineers, 1881, page 1831, and 1884, page 1637.

After having made a personal examination, I concur in the views of that officer that this locality is not worthy of improvement by the Government because there is no present or prospective navigation of the river.

MANKATO.

I have examined this locality and find the conditions nearly identical with those at Belle Plaine. If there was any navigation on the river it might be deemed advisable to protect caving banks in places where a good channel would be held in a suitable location thereby, but there is no navigation on this part of the Minnesota River now, and the locality is not considered worthy of improvement.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., January 22, 1895.

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the conclusions reached by Major Jones, the district engineer.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

Y 11.

PRELIMINARY EXAMINATION OF BIG STONE LAKE, MINNESOTA, WITH A VIEW TO CONSTRUCTION OF RESERVOIRS.

[Printed in House Ex. Doc. No. 256, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 23, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 16, 1895, by Maj. W. A. Jones, Corps of Engineers, of the results of a preliminary examination of Big Stone Lake, Minnesota, "with a view to construction of reservoirs," made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Jones reports that this improvement is legitimately a part of the project creating reservoirs at the head waters of the Mississippi River, and, for the reason given, considers the locality worthy of improvement. The division engineer, Col. O. M. Poe, Corps of Engineers, reports that in his opinion "Big Stone Lake, with a view to the construction of reservoirs," is worthy of improvement by the General Government.

The Board of Engineers, in a report of May 24, 1887, upon the subject of reservoirs at head waters of the Mississippi River and its tributaries, made after an exhaustive inquiry, uses the following language: "The further extension of the system of improving low-water navigation by reservoirs in this region is not recommended by the Board." (See Annual Report of the Chief of Engineers for 1887, Part II, pp. 1681–1693.)

I do not consider the work now proposed an improvement worthy to be made by the General Government.

Major Jones estimates that the surveys necessary for preparation of plan of improvement, with estimates, will cost $3,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 16, 1895.

GENERAL: In compliance with instructions contained in Department letter of August 20, 1894, I have the honor to submit report of a preliminary examination of "Big Stone Lake, with a view to construction of reservoirs."

The utilization of Big Stone Lake as a reservoir for storing water to apply to the improvement of the Mississippi River at and below St. Paul, Minn., involves a consideration of Lake Traverse, with a view to uniting the two lakes into one reservoir. These two lakes are located in the midst of a great prairie, almost exactly upon the divide between waters flowing south via the Minnesota River to the Gulf of Mexico and those flowing north via the Red River of the North into Hudson Bay. They lie in deep basins, about 150 feet below the level of the prairie. A reservoir can be created here whose waters could be discharged indifferently in either direction.

Big Stone Lake is on the main run-off line of the waters of the Minnesota River. It draws from the watersheds of both that river and the Whetstone, about 1,636 square miles in extent. It is about 25 miles long and from 1 to 2 miles wide. Low-water area, 18 square miles; average low-water depth, about 10 feet. Its banks are well defined, and the narrow valley slopes steeply from the water's edge 150 feet upward to the prairie level. At the lower end the valley is wholly marsh and meadow.

A low strip of land about 5 miles across separates this lake from Lake Traverse. Located upon this strip is the flourishing town of Browns Valley. At the southern extremity the large towns of Ortonville and Big Stone face each other across the boundary between Minnesota and South Dakota. A branch of the Chicago, Milwaukee and St. Paul Railroad passes through Ortonville from the south, and, reaching around to the north, crosses the Bois de Sioux River at the head of Lake Traverse. A branch of the Great Northern Railroad terminates at Browns Valley.

The Minnesota River enters Browns Valley from the west, near the upper end of Lake Traverse, and continues its course to about midway between the bluffs. Here it turns sharply to the south, and enters Big Stone Lake. At its point of entrance into the valley it is only 3 feet above Lake Traverse. During freshets it frequently overflows its banks and discharges the surplus into the latter lake. During spring freshets Big Stone Lake is ordinarily raised from 5 to 10 feet above low water. The great bulk of the run-off from the rainfall in this locality escapes during the months of May and June. Thereafter the rainfall is slight, and is largely absorbed by the porous soil.

Lake Traverse is about 30 miles long, with topographical conditions almost identical with Big Stone Lake. Its low-water level is 7.2 feet higher, with a range to high water of about 4 feet. The drainage area is 1,280 square miles. The summit of the valley between the two lakes is about 10 feet above Lake Traverse and 17 feet above Big Stone Lake.

The Minnesota and Whetstone rivers are subject to very heavy spring freshets, and if these were held back in a large reservoir the lower valley would not only be largely relieved from damage by floods, but these waters could be utilized for navigation later in the season.

By making a cut between these two lakes of sufficient depth to bring their waters to the same level we will have a permanent deep-water

transportation line 60 miles in extent, from the foot of Big Stone Lake to the foot of Lake Traverse. The whole line is in a very fertile country, which by means of it would be afforded a railroad outlet at each extremity.

By converting the two lakes into a reservoir, by means of a dam at the lower extremity of each, the flood waters of the Upper Minnesota, Whetstone, and Bois de Sioux rivers could be assembled and held under control for delivery during low-water seasons upon the Mississippi River at and below St. Paul, and upon the Red River of the North, to the very great benefit of navigation.

The drainage area tributary is 2,916 square miles. The mean annual rainfall is 21.2 inches. A run-off of 20 per cent would furnish, in round numbers, 33,000,000,000 cubic feet for storage. This is largely in excess of the capacity of the proposed reservoir, and since the benefits of ponded water upon the Mississippi River are very great, and fully demonstrated by experience, I recommend that the survey in this case be made to include additional storage sites below Big Stone Lake on the Minnesota River at Lac qui Parle and Pomme de Terre. Owing to peculiarities of its watershed, the rainfall tributary to the Minnesota River runs off with a gush in the floods of May and June, leaving but a scanty supply of water thereafter.

It should be added that this improvement is legitimately a part of the project creating reservoirs at headwaters of the Mississippi River.

For the foregoing reasons, I consider the locality worthy of improvement. The sum of $3,000 will be required to make the necessary surveys.

For commercial statistics reference is made to the inclosed official statement from the Ortonville Board of Trade. Reference is also made to statistics of commerce on Upper Mississippi River.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., January 18, 1895.

Respectfully forwarded to the office of the Chief of Engineers.

As a part of the reservoir system for the Mississippi River, already approved, "Big Stone Lake, with a view to the construction of reservoirs," is, in my opinion, worthy of improvement by the General Government. Although Lake Traverse is not included by name in the act of Congress, yet its relations to Big Stone Lake are such that it must necessarily be included in any survey and examination of the latter, with a view to the formation of a reservoir. It is more doubtful in regard to surveys and examinations of Minnesota River below Big Stone Lake, but it is very desirable that they be included in case the law will permit.

The estimate of cost is approved.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

STATEMENT OF THE ORTONVILLE BOARD OF TRADE.

ORTONVILLE, MINN., *January 3, 1895.*

SIR: The committee appointed by our board of trade to investigate and report past, present, and prospective commerce on Lakes Big Stone and Traverse, and the shipments from Ortonville, Minn., and Big Stone City, S. Dak., for 1893 (both towns at the foot of Big Stone Lake), reports as follows:

Shipments of wheat, 510 cars; flax, 5 cars; potatoes and onions, 18 cars; granite, 600 cars; live stock, 15 cars. Received, 155 cars of coal. Freight paid by 14 firms at Ortonville alone amounts to $19,700. Big Stone City and other small firms will add $10,000 more.

As to the commerce on the lakes the committee finds that in 1884 the Chicago, Milwaukee and St. Paul operated a steamboat on Big Stone that brought into Ortonville for shipment 75,000 bushels of wheat. This boat was destroyed by fire.

The committee finds that there are 256,000 acres within 5 miles of the shore line of Big Stone Lake, and 192,000 of Lake Traverse, making a total of 448,000 acres, capable of producing 2,000,000 bushels of wheat, 1,000,000 bushels of flax, and 500,000 of coarse grain. In addition to the above we have set aside the fertile valley bordering on the lakes, capable of producing large quantities of vegetable, poultry, and dairy products for shipment to the markets of the country.

Respectfully submitted.

S. H. SCHOLBERG,
Secretary Board of Trade.

W. A. JONES,
Major, United States Army.

Y 12.

PRELIMINARY EXAMINATION OF RED LAKE RIVER, MINNESOTA, WITH THE VIEW OF IMPROVING RED LAKE RIVER FROM THIEF RIVER FALLS TO THE RED LAKE.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 26, 1895.

GENERAL: I have the honor to make the following report of a preliminary examination of "Red Lake River, Minnesota, with the view of improving Red Lake River from Thief River Falls to the Red Lake."

This locality is considered worthy of improvement for the following reasons:

Red Lake River is the drainage outlet of Red Lake and the country tributary thereto. From Thief River Falls up to High Landing, a distance by river of 34.67 miles (air line about 20 miles), there is a fall of 38.67 feet. From this point to Red Lake, a distance of about 24 miles in an air line and approximately 50 miles by river, the fall is slight, and but little will be necessary to enable boats drawing 3 feet to navigate. Red Lake is composed of two large lakes connected by a narrow thoroughfare. The two lakes are each about 25 miles long.

The water transportation line which may be opened by this improvement is therefore comprised in three reaches:

1. Red Lake, 50 miles long.
2. Red Lake River from Red Lake to High Landing.
3. Red Lake River from High Landing to Thief River Falls.

The Red Lake reach is navigable without further improvement. The river from the lake to High Landing is navigable without improvement excepting a small bar in the lake and river at the outlet. This can be cleared out at a nominal expense.

The river between High Landing and Thief River Falls is navigable except during low stages. The obstructions are bowlders, single and en masse. They can be removed in the winter season at a low cost

so as to make a channel of 3 feet depth at low stages which steamboats can navigate.

The transportation line which it is sought to improve lies in a country very fertile, but mostly unsettled on account of having no transportation outlet. It extends from the prairie of the Red River Valley into the heart of the great Minnesota forest. Estimating a belt 5 miles wide on each side as normally tributary, we will have an area of 940 square miles from which the commerce will be drawn.

The Red Lake Indian Agency would be supplied by this line, saving the Government considerable in the way of wagon transportation over a line 75 miles long.

Two or three small steamers have been engaged in traffic between Thief River Falls and points on Red Lake during high stages, but I am unable to state the volume of business done by them.

A map of the locality is herewith.

At Thief River Falls connection is made with the Great Northern Railroad system.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., February 28, 1895.

Respectfully forwarded to the office of the Chief of Engineers.

To the extent proposed in this report I concur in the opinion of the district engineer that the locality is worthy of improvement by the General Government.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

APPENDIX Z.

IMPROVEMENT OF MISSOURI RIVER AT AND ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Missouri River between Stubbs Ferry, Montana, and lower limits of Sioux City, Iowa.
2. Removal of snags and other obstructions in Missouri River above Sioux City, Iowa.
3. Yellowstone River, Montana and North Dakota.

EXAMINATIONS.

4. Nebraska side of Missouri River opposite Sioux City, Iowa.
5. Tongue River, Montana.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, July 10, 1895.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge during the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF UPPER MISSOURI RIVER BETWEEN STUBBS FERRY, IN MONTANA, AND THE LOWER LIMITS OF SIOUX CITY, IOWA.

Prior to August 17, 1894, the improvement of the upper Missouri River was confined to the distance of 1,480 miles lying between Sioux City and Fort Benton. By the river and harbor act of the above date

the limits of improvement were extended to include the distance of 180 miles lying between Fort Benton and Stubbs Ferry.

APPROPRIATIONS.

Including the sum of $40,000, which has been allotted to bank protection at Sioux City from the appropriation of 1895 for improving Missouri River from mouth to Sioux City, the appropriations and allotments for the upper Missouri River have been as follows:

1876	$20,000	1886	$60,000
1878	42,500	1888*	200,000
1879	60,000	1890	300,000
1880	43,000	1892	150,000
1881	66,000	1894	110,000
1882	115,000	1895†	40,000
1884	140,000		

In addition to the above-specified amounts, a sum of about $60,000 from the appropriations for the survey of the river from Fort Benton to the mouth was spent on the part above Sioux City.

OPERATIONS.

From Stubbs Ferry to Great Falls.—This reach is 131 miles long. At the beginning of the year it was practically in its original condition. No work had been done on it since 1883. Prior to that time a small amount of work had been done at Beartooth Shoal and Rapids and at Halfbreed Rapids.

From Stubbs Ferry to a rapid just below Cascade the slope of the river is very great, averaging 3.73 feet per mile for the distance of 77 miles. In one stretch, 2 miles long, the total fall is 19 feet, and there are many places where for short distances the slope exceeds 9½ feet to the mile. The steepest slope is at Halfbreed Rapids, where for about half a mile it is 18.16 feet to the mile. The low-water depth generally exceeds 2½ feet. It is less than that at fifteen places. In addition to the steepness of the slope, the channel is frequently obstructed by bowlders.

From the Cascade rapids to the town of Great Falls the river has a very gentle slope, averaging 0.52 feet to the mile for the total distance of 54 miles. This stretch is called the Long Pool. The channel is generally more than 3 feet deep at low water, but is obstructed as follows:

At Thurmans Bar, 37.6 miles above Great Falls, by a sandy shoal with low-water depth of 2 feet.

At Griffin's Bar, 13 miles above Great Falls, by a sandy shoal with low-water depth of 1.8 feet.

At Westcott Island, 9 miles above Great Falls, by a sandy shoal with low-water depth of 1.5 feet.

At Fox Island, 5.1 miles above Great Falls, by a sandy shoal with low-water depth of 2.5 feet.

At Whitebear and Wickners islands, 4 miles above Great Falls, by a sandy shoal with low-water depth of 2.5 feet.

At Great Falls Island, 2 miles above Great Falls, by the piers of an old log boom and by a sandy shoal which makes the channel difficult to run, although a depth of 3 feet or more can be found at low water.

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*Allotment from general appropriation for the improvement of the river from Fort Benton to the mouth.

†Allotment from the sundry civil appropriation for improving Missouri River from mouth to Sioux City.

The project for this reach contemplates the construction of a small plant, the removal of obstructions, and the contraction of the waterway to give an available low-water depth of 2½ feet from Stubbs Ferry to Cascade, and of 3 feet from Cascade to Great Falls. The total estimated cost is $165,812.50, with an annual maintenance charge of $4,500.

During the fiscal year ending June 30, 1895, work was begun under an allotment of $20,000 from the appropriation for improving the upper Missouri River, in the river and harbor act of August 17, 1894, The obstructions were first surveyed in the autumn of 1894. A small plant was constructed during the winter, and field work was begun in the spring.

As results of this work the piers obstructing the channel at Great Falls Island have been removed, the chutes in rear of Whitebear and Wickners islands have been closed by dams, and spur dikes have been built out from the point of each of these islands, to contract the channel and increase the depth on the bar. A third dike, projecting from the bank above Wickners Island, is contemplated; but it is hoped from present indications to obtain the necessary depth without constructing it.

Work has also been begun on the dam to close the chute in rear of Fox Island. Three spur dikes, extending from the bank opposite the island, form part of the project at this locality. They have not yet been begun.

A map is herewith, showing the completed and projected works at the two places named. The dams and dikes are built of alternate layers of mattresses and stone. The mattresses are made of brush fascines bound together by poles and wire. The dikes are provided with a T head at the river end.

The materials have been found in the immediate vicinity of the work, the privileges of quarrying and cutting brush having been obtained without charge.

A total of 439 cords of brush and 2,048 cubic yards of stone has been built into the work. The total expenditures during the year have been $9,164.90.

The work has been done by hire of labor and purchase of material, and has been under the local charge of Mr. E. D. Vincent, assistant engineer, whose report is appended.

Great Falls to Fort Benton.—This reach is 49 miles long. At the beginning of the year it was in its natural condition. It is almost a continuous rapid and is not susceptible of open-river improvement. No work has been done on it nor is any projected.

Fort Benton to Carroll.—The approved project for this reach of 172 miles contemplates the removal of obstructions and the contraction of the waterway by dams and dikes to produce a better low-water navigation than naturally existed. The estimated cost is $720,345.46.*

At the beginning of the year the condition was the same as described in the last Annual Report. The dams and dikes constructed during the years 1877 to 1881 have suffered considerably since put in place, and the channels which were dredged have not remained open. No work was done during the year, navigation having ceased.

The balance of $7,801.82 remaining unexpended of the allotments for work on this reach of the river was transferred to the allotment for removing obstructions and used in the maintenance of the snag boats.

* Including the cost of works executed before the completion of the present project.

From Carroll to Sioux City.—The project for this reach of 1,308 miles contemplates a number of works, as follows:

At Bismarck Harbor.—The complete rectification of the river at this place would require the contraction of the channel to suitable width and the protection of the banks from Rockhaven, 5 miles above Bismarck, to Fort Lincoln, 5 miles below. Between these points the channel is changeable and the banks liable to erosion.

By the river and harbor act of August 17, 1894, an amount of $40,000 was allotted to the "protection of Bismarck Harbor and the rectification of the river by works to prevent the river from eroding the bank and cutting a new channel at or near that point." The work projected with this sum is the commencement of a group of eight spur dikes on the right bank of the river to check the tendency to cut the bank about three-fourths of a mile above the bridge of the Northern Pacific Railroad. It was estimated that six of the dikes could be finished.

This work is only a small part of that necessary for the complete rectification as outlined above. The approval of the Department extends only to the work to be done with the funds already appropriated.

The dikes are of the type to be described in the report of the work at Sioux City, differing from the latter only in the construction of the foot mat, which is not woven, but made of three layers of brush 4 inches thick, lying at right angles to each other and securely clamped between frames of scantling.

At the beginning of the fiscal year the river in this vicinity was in its natural condition. The work of improvement was not authorized by the War Department until February 25, 1895. It was then too late to undertake any construction until after the summer flood.

During the fiscal year the plant necessary for the work, including a scow equipped with a Vulcan steam pile hammer, has been constructed and the dike material purchased. The lumber and piles are of Oregon fir and were bought, respectively, from Inman, Poulsen & Co., of Portland, Oreg., and Charles King, of Tacoma, Wash. The brush was cut in the neighborhood and piled in readiness.

The stone, consisting of 7,000 cubic yards, was offered by the Northern Pacific Railway Company from a pile which it had hauled and stored on the bank.

The actual dike construction was begun in June, 1894. Two mattresses were built.

The work has been done by hire of labor and is under the local charge of Mr. H. C. Gould, assistant engineer, whose report is herewith. The expenditures during the fiscal year have been $6,496.43.

At Pierre and Fort Pierre.—At the beginning of the fiscal year the river at this locality was in its natural condition. The steamboat landing at Pierre had silted up until it had become inconvenient and dangerous at low water and the bank was cutting in places.

To restore the landing and properly direct the channel along the town front would require the contraction of the low-water flow by dikes and revetments for a distance of about 7 miles.

The river and harbor act of August 17, 1894, allotted $40,000 to the "rectification of the river at Pierre and Fort Pierre." With this sum it was proposed to construct a group of five dikes and a dam across the chute in rear of Marion Island and to begin work on a group of dikes on the Pierre side. It is thought that one of the latter can be finished. These works form part of a general scheme of rectification by which it is intended to confine the low-water flow of the river to a channel 700

feet wide with suitable direction and landing places. Only the portion to be executed with the funds now available has yet been approved.

The dikes are permeable pile dikes with foot mats of the same construction as those used in the work at Bismarck Harbor. The dam is constructed of brush cribs weighted with stone.

During the year ending June 30, 1895, the material for the works and for the plant was purchased and the plant constructed. The stone was bought under formal contract with Cyrus B. Ingham, of Pierre, S. Dak., and was furnished promptly and satisfactorily. The lumber for dikes and plant was ordered under formal contract with James H. Owen, of Pierre, S. Dak., which should have been completed on March 1, 1895, but was extended until June 1, 1895. After many vexatious delays about 92,000 feet of the lumber called for was furnished and a great deal offered and rejected on inspection. To avoid further delay to the work the remainder of the lumber was purchased in open market.

The piling for the dikes was purchased from E. R. Bullens, of Kansas City, Mo., and was delivered in time and of satisfactory quality.

The necessary hardware for the plant and dikes was purchased of various dealers.

A plant consisting of the necessary barges and a pile-driving scow equipped with a Vulcan steam hammer was constructed and equipped.

The dam in rear of Marion Island was begun and about three-fourths completed.

A total amount of 3,371 cubic yards of stone, 153,000 feet, B. M., of lumber, and 386 piles have been purchased or ordered.

The work has been done by hire of labor and is under the local charge of Mr. W. G. Price, assistant engineer, whose detailed report is herewith.

At Sioux City.—At the beginning of the fiscal year the work which had been done in this locality consisted of a small amount of mattress and dike work, suspended in 1882, and a group of nine spur dikes of screened piling placed in a pocket of the Iowa bank opposite the main part of Sioux City to check a dangerous erosion. These dikes were built in 1889 by the Missouri River Commission.

The group had fulfilled its purpose admirably, having caused a fill reaching above high water of an ordinary flood. The accretions had, however, not filled out to the extreme ends of the dikes, which are left exposed to the ice and drift brought down by the current. Being unprotected by T heads or buttresses, they had suffered to some extent, a few bents of piles having washed out. In addition, the river had begun to cut in above the whole group and threatened its ultimate destruction, though the danger was not immediate.

No other works had ever been constructed by the Government along the Sioux City front.

The river at and above the city is wide and has no fixed channel. It has attacked the bank on the Iowa side at a place about one mile and a half above the group of dikes already mentioned and has cut the Nebraska bank very seriously along the front of the town of South Sioux City. For all but about 4,000 yards of the part attacked the latter bank has been protected by a mattress revetment constructed by the railroad and bridge interests.

The complete rectification of the river in this vicinity would require the contraction of the channel to a suitable width for a distance of about 5 miles by spur dikes supplemented by mattress revetments.

The funds available for this work during the year ending June 30, 1895, were provided by a sum of $10,000 from the river and harbor

appropriation of August 17, 1894, for improving upper Missouri River, allotted to the protection and completion of the works at Sioux City; and a sum of $40,000 from the sundry civil appropriation of March 2, 1895, for improving Missouri River from its mouth to Sioux City, allotted to the protection of the banks of the Missouri River in front of Sioux City and on the Iowa side.

With the first allotment of $10,000 the work projected was the construction of two spur dikes immediately above the old system to stop the cutting which was beginning there, and the protection of the ends of the old dikes by T heads so far as the funds should permit. It was estimated that the two new dikes and one T head could be constructed.

During the winter the materials were collected and a small tender was put in repair. Contract was made with George Adgate, of Sioux City, Iowa, and with Frank D. Halm, of Jasper, Minn., for the necessary broken stone; with Goodrich & Robson, of Sioux City, Iowa, for furnishing and driving piles; and informal agreements with various persons for furnishing brush, hardware, and miscellaneous articles. F. D. Halm failed to fulfill his contract, which was carried out by his bondsmen at the specified rate. The remaining contracts were completed on time and satisfactorily.

The work of construction was begun as early in the spring as the condition of the river would permit, and was finished in May, 1895. The two new dikes and two T heads for the old group were built before the funds were exhausted.

The construction and location of the dikes is shown on the accompanying drawings. In executing the work the foot mat, which is woven of brush, was first made and sunk in position by a small amount of rock. The piles were then driven through it. The remainder of the stone was subsequently thrown on, and the dikes waled, braced, and screened with poles placed about four inches apart in the clear. One thousand eight hundred cubic yards of stone, 126 white oak piles, 8,500 feet, B. M., of pine lumber, and 444 cords of brush were used.

The piles were furnished and driven by contract. The remainder of the work was done by hired labor.

The dikes and T heads have not been in place long enough to give any indication of their stability. They have already caused accretions to form, reaching well above low water, and extending 100 feet or more below the ends of the heads. It is hoped that in the course of a few seasons they will build out the bank nearly to their extremities.

The cost of this work was $10,000.

The project for the expenditure of the allotment of $40,000 from the sundry civil act of 1895 contemplates the construction of spur dikes at the cutting bluff, one and one-half miles above the old work. Twenty dikes are projected, spaced from 200 to 300 feet apart, and varying from 100 to 500 feet long. The construction of the dikes is the same as that in the work lower down. The available funds are estimated to be sufficient for the first 15 dikes.

The work was not undertaken early enough to permit beginning the construction before the subsidence of the summer's flood. The piles have been ordered from The McLeod Lumber Company, of St. Louis, Mo., and the St. Paul Timber and Supply Company, of St. Paul, Minn. The lumber has been bought from the Capital Lumbering Company, of Winlock, Wash., and the stone from Fowler & Pay, of Mankato, Minn., and from George Adgate, of Sioux City, Iowa. In all these purchases advantage has been taken of the land-grant rates for freight shipment, the prices of the delivered materials being considerably reduced thereby.

To avoid the necessity of equipping a pile driver, the piles are to be sunk by contract. The remainder of the work is to be done by hired labor, as in the work lower down.

The total sum of $884.75 has been expended during the fiscal year from the sundry civil allotment.

The entire work at Sioux City has been under the local charge of Mr. F. M. Tower, assistant engineer, whose report is appended.

Ice harbors.—Funds for the construction of two ice harbors were provided by the river and harbor act of September 19, 1890. One of these is located at Rock Haven, N. Dak. The project contemplates the acquisition of a strip of land 1 mile long on the right bank of the river, at a place where the natural configuration of the river bank causes the ice to run clear of the latter; grading the bank on a smooth slope to the low-water mark; constructing a bank or levee at the top of the graded slope, the upper surface to be above high water; planting mooring posts; forming the upper end of the levee into a projecting spur dike; constructing an incline for hauling out vessels at the lower end, and dredging or sluicing to a low-water depth of 4 feet along the front. An allotment of $35,000 from the appropriation of 1890 was made to cover the expenses of construction.

At the beginning of the fiscal year, title to about half the land had been obtained and the levee constructed for about one-fourth of the total projected distance. The mooring posts had been obtained and placed.

During the year ending June 30, 1895, the work on the land already acquired by the Government was finished and the title to the remainder was acquired. Operations were necessarily suspended during the winter and will be resumed after the subsidence of the summer flood.

The work has been done by hired labor, and has been under the local charge of Mr. H. C. Gould, assistant engineer.

The expenditure during the year has been $16,112.89.

The second of the two ice harbors has been located on the South Dakota bank of the Big Sioux River, near its mouth. The project contemplates raising a levee above high water, planting mooring posts, grading the bank, and making an incline for hauling out boats. The estimated cost is $9,000.

At the close of the last fiscal year the site had been surveyed, and operations suspended pending the cession of jurisdiction by the State of South Dakota.

During the year ending June 30, 1895, jurisdiction has been ceeded by the State, and negotiations for the purchase of the land has been in progress.

No expenditures have yet been made from the allotment for construction.

River survey.—The project for the work contemplates the completion of a detailed survey from Fort Benton to Sioux City.

Two series of maps are plotted. The first, or detail charts, are lithographed and printed on scales of $\frac{1}{7920}$ for the part above the Yellowstone and of $\frac{1}{12000}$ for the part below. The second series of small-scale maps is on a scale of two inches to the mile, and is not published.

From the amounts expended and reported in 1891 as necessary to finish the work, the estimated cost of that remaining unfinished when turned over by the Missouri River Commission in 1890 may be stated at $149,497.

At the beginning of the fiscal year the field work extending over 1,477 miles of river had been finished; the plotting of 198 detail charts finished, completing the series except for the index charts; the

the river, but will advance the general scheme for rectification. From an engineering standpoint the expenditure will be profitable in furthering the works, and the amounts are included in the appended money statement.

It is not my duty to express in this report any opinion as to the propriety of continuing these improvements. The facts, which it is my duty to state, are that the approximate cost will be as given above; that the works will be of very great local benefit and will be in line with a project the execution of which will ultimately increase the navigability of the river; that the cost of such a general improvement is estimated to average $38,500 per mile of channel, and that the present commerce on the Missouri between the Yellowstone and Sioux City is about 25,000 tons annually.

Money statement.

July 1, 1894, balance unexpended		$93,064.48
Amount appropriated by act of August 17, 1894		110,000.00
Amount appropriated by sundry civil act of March 2, 1895		40,000.00
Amount received from overpayment		5.30
		243,069.78
June 30, 1895, amount expended during fiscal year		108,407.17
July 1, 1895, balance unexpended		134,662.61
July 1, 1895, outstanding liabilities	$34,121.92	
July 1, 1895, amount covered by uncompleted contracts	623.00	
		34,744.92
July 1, 1895, balance available		99,917.69
Amount (estimated) required for completion of existing project		338,959.78
Amount that can be profitably expended in fiscal year ending June 30, 1897		*362,812.50

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for furnishing lumber, piling, and broken stone at Pierre, S. Dak., opened by Capt. H. F. Hodges, Corps of Engineers, at Sioux City, Iowa, in accordance with advertisement dated November 26, 1894, at 2.30 p. m., December 17, 1894.

No.	Name and address of bidder.	Bill of lumber.					Bill of piling.		Bill of stone.		Remarks.
		Lot 1, M feet, B. M.	Lot 2, M feet, B. M.	Lot 3, M feet, B. M.	Lot 4, M feet, B. M.	Lot 5, M feet, B. M.	Lot 6, linear foot, right bank.	Lot 6, linear foot, left bank.	Lot 7, cubic yard, right bank.	Lot 7, cubic yard, left bank.	
a1	James H. Owen, Pierre, S. Dak.	$30.00	$30.00	$29.00	$20.90	$20.90	$36.90	$35.00	$2.49	$2.24	Conditional.
b2	Cyrus B. Ingham, Hughes County, Pierre, S. Dak.	.....	.....	.....	.....	.....	.....	.....	1.73	1.07	Lacks seals.
3	Josef Stainer, Hughes County, Pierre, S. Dak.	.....	.....	.....	.....	.....	.....	.....	3.95	2.95	
4	John R. Heald (probably), Fort Pierre, S. Dak.	.....	.....	.....	.....	.....	.....	.....	2.90	.....	Lacks seals.
5	E. P. Cowen Lumber Co., Kansas City, Mo.	$35.00 $30.00	30.00	32.00	28.00	28.00	.....	31¢	.....	.....	Proposal lacks seal. Amended by telegraph.
6	William Hayes, Fort Pierre, S. Dak.	.....	.....	.....	.....	.....	.....	.....	2.89	2.89	

a Contract awarded to James H. Owen for lumber.
b Contract awarded to Cyrus B. Ingham for broken stone.

* Not including $50,000 annually for removing obstructions.

Abstract of proposals for furnishing materials and driving piles at Sioux City, Iowa, opened by Capt. H. F. Hodges, Corps of Engineers, January 14, 1895, in accordance with advertisement dated December 13, 1894.

No.	Name and address of bidder.	Lot No. 1, sawed lumber, per M. feet.	Lot No. 2, broken stone, per cubic yard.	Lot No. 3, furnishing and driving piles, per linear foot.	Remarks.
1	Henry Hall, Florence, Douglas County, Nebr.	.....	.....	$0.48	No seal on proposal.
*2	George Adgate, Sioux City, Iowa..	$23.25	$1.89	.42.5	
†3	Goodrich & Robson, Sioux City, Iowa.	18.75	1.94	.33.4 .32	White-oak piles. Norway pine piles.
‡4	John W. Smith, Sioux City, Iowa..	18.50	1.95	.45	
5	Frank N. Truax, St. Paul, Minn...	.....	4.50	.....	No seals; no inside envelope.
*6	Frank D. Halm, Jasper, Pipestone County, Minn.	.....	1.89	.....	

* Contract awarded to George Adgate and Frank D. Halm for broken stone.
† Contract awarded to Goodrich & Robson for white-oak piles.
‡ Contract awarded to John W. Smith for sawed lumber.

Abstract of bids for furnishing coal for U. S. steam snag boats, opened by Capt. H. F. Hodges, Corps of Engineers, 2.30 p. m., April 1, 1895.

No.	Name and address of bidder.	About 300 tons, Sioux City, Iowa.		About 250 tons, Running Water, S. Dak.		About 100 tons, Chamberlain, S. Dak.	
		Price per ton.	Amount.	Price per ton.	Amount.	Price per ton.	Amount.
1	Herl Coal Co., Brazil, Iowa.....	$2.76	$828	$4.00	$1,000.00	$3.50	$350
2	Lester H. Clow, Pierre, S. Dak.....	.....	.....	.....	.....	.....	.....
*3	L. G. Everist, Sioux City, Iowa	2.75	825	4.30	1,075.00	5.75	475
4	Lester H. Clow, Pierre, S. Dak.....	3.16	948	4.45	1,112.50	4.98	498
5	James H. Owen, Pierre, S. Dak.....	.....	.....	.....	.....	.....	.....
6	Brown-Bowers Coal Co., Sioux City, Iowa	3.20	960	4.50	1,125.00	5.05	505
7	James W. Sanford, Chamberlain, S. Dak.....	.....	.....	.....	.....	5.40	540
8	W. L. McCauley, Sioux City, Iowa.....	3.00	900	4.25	1,062.50	4.75	475
9	E. A. Conway, Sioux City, Iowa.....	3.26	978	4.60	1,150.00	5.10	510

No.	Name and address of bidder.	About 300 tons, Pierre, S. Dak.		Kind of coal.	Remarks.
		Price per ton.	Amount.		
1	Herl Coal Co., Brazil, Iowa.	$4.65	$1,395	Walnut block.	Not in duplicate. Guarantors' signatures not witnessed. No seals. Justified before notary public. No evidence of authority to sign bid.
2	Lester H. Clow, Pierre, S. Dak.	4.85	1,455	.....do	No seals. Justified before notary public.
*3	L. G. Everist, Sioux City, Iowa.	4.60	1,380	4 mines	No seals. Guarantors' signatures not witnessed.
4	Lester H. Clow, Pierre, S. Dak.	.....	.....	Walnut block.	No seals. Name of place left out of one proposal.
5	James H. Owens, Pierre, S. Dak.	4.84	1,452	.....do	No seals.
6	Brown-Bowers Coal Co., Sioux City, Iowa.	4.95	1,485	.....do	No seals. Signed, "Brown-Bowers Coal Co."
7	James W. Sanford, Chamberlain, S. Dak.	.....	.....	.....	
8	W. L. McCauley, Sioux City, Iowa.	4.70	1,410	.....	Conditional. No guaranty.
9	E. A. Conway, Sioux City, Iowa.	4.95	1,485	.....	No seals.

* Contract awarded L. G. Everist.

REPORT OF MR. EDWIN D. VINCENT, ASSISTANT ENGINEER.

GREAT FALLS, MONT., *June 30, 1895.*

CAPTAIN: I have the honor to make the following report of the Missouri River from Stubbs Ferry, Mont., to the head of the Great Falls, covering a distance of 131 miles:

The report treats in a general way of the principal characteristics of that reach of the river, but more particularly of the existing obstructions to navigation and of the improvement work that has been commenced with a view of securing a depth of channel of 3 feet over all at extreme low water. The Missouri River from Stubbs Ferry to the Great Falls comprises two stretches differing so entirely in their characters that I have for convenience designated them the upper and lower reach and have described each one separately.

The general course of the river from Stubbs Ferry is to the northwest for about 45 miles to the entrance of the Little Prickly Pear Creek; it then turns and runs in a northeasterly direction until it passes the Great Falls. The first or upper reach extends from Stubbs Ferry, 81 miles below the source of the Missouri, to the town of Cascade, a distance of 77 miles. From Stubbs Ferry the river enters or breaks through the last great chain of the Rocky Mountains, the range thus bisected being known on the east side as the Big Belt Mountains and on the west as the Dearborn Range. The river in its passage runs through a succession of canyons and small valleys.

The stream narrows down, being from 200 feet to 500 feet wide, although it widens occasionally to 800 feet, where the channel is obstructed by islands; and almost invariably where this is the case the waterways between are choked with bars of sand and gravel, the depth over them being from 2 to 3 feet at extreme low water.

Twenty miles below Stubbs Ferry the river enters that extraordinary canyon named by Lewis and Clark "The Gates of the Rocky Mountains," and in describing that remarkable gorge I quote the following from the journal of those distinguished explorers, dated July 19, 1805: "A mile and a half beyond this creek (now called Willow) the rocks approach the river on both sides, forming a most sublime and extraordinary spectacle. For 5¼ miles these rocks rise perpendicular from the water's edge to the height of nearly 1,200 feet. They are composed of black granite near their base, but from the lighter color above and from fragments we suppose the upper part to be flint of yellowish brown and cream color. * * * The river, 150 yards in width, seems to have forced itself down this solid mass; but so reluctantly has it given way that during the whole distance the water is very deep, even at the edges, and for the first 3 miles there is not a spot, except one of a few yards, in which a man could stand between the water and the towering perpendicular of the mountain.

"The convulsion of the passage must have been terrible, since at its outlet there are vast columns of rock torn from the mountain which are strewn on both sides of the river. * * * Several fine springs burst from the chasms of the rocks and contribute to increase the river, which has a very strong current. * * * This extraordinary range of rocks we called the Gates of the Rocky Mountains."

The river for the greater part of the way over this, the upper, reach has a free channel, with water to the depth of from 4 to 12 feet at the extreme low stage. Besides the bars already mentioned the stream is partially obstructed in places by isolated bowlders, which have been either carried there or thrown from the cliffs.

The river is clear, with a gravelly or rocky bed and stable banks.

The current is very swift over the entire reach. The fall from the foot of Flume Ripple, 1,000 feet below the Missouri River Power Company's dam site, which is located 1,600 feet below Stubbs Ferry, to the foot of Cotttonwood Ripple, 1 mile below the town of Cascade, a distance of 73.5 miles, is 273.23 feet, or at the rate of 3.71 feet per mile.

The fall, more in detail, is as follows: From the foot of Flume Ripple to the head of the Bear Tooth Rapids, a distance of 22.5 miles, the fall is 80.1 feet, or 3.5 feet per mile.

These rapids are a very serious obstruction, the channel being crooked and filled with bowlders. The depth of water is about 3 feet at the extreme low stage. The slope is 5.6 feet for a distance of 3,000 feet, or at the rate of 9.9 feet per mile.

From the foot of Bear Tooth Rapids to the head of Brunots Rapids, a distance of 36 miles, the fall is 131.5 feet, a rate of 3.8 feet per mile. The fall over Brunots Rapids, covering a distance of 2,000 feet, is 3.3 feet, a rate of 8.7 feet per mile.

From the foot of Brunots Rapids to the head of the Lone Pine or Half-Breed Rapids, a distance of 1.9 miles, the river falls 5.8 feet, or at the rate of 3 feet per mile. It is on this reach the river forces itself through the last canyon of the Rocky Mountain system. The walls are a granite formation and rise in places to a height of 600 feet.

The Half-Breed Rapids probably constitute the worst obstruction in the whole length of the Missouri outside of that reach covered by the Great Falls.

These rapids are situated 65 miles below Stubbs Ferry.

The river here is closely hemmed in by the mountains, and immediately at the head of the rapids it is divided by an island one-fourth of a mile long into two equal channels, each from 200 to 400 feet wide. The west chute carries the greater volume of the water, the east one being obstructed by gravel bars and islands.

The west channel is obstructed by bowlders, several being of immense size, especially at the head of the island; again, where the two channels join below, the river is filled with these water-washed rocks, some coming just to the surface, but the greater portion being submerged.

None of these rocks seem to be in place, but have apparently been carried there by the force of the current or thrown down from the mountain side by some convulsion.

For 3,000 feet the water rushes over these obstructions with tremendous force, the fall in that distance being 10 feet, a rate of 17.6 feet per mile.

From the Half-Breed Rapids to Cascade, the foot of the first reach, the force of the water diminishes, although the current is still strong. The fall is 37 feet in 11.5 miles, a rate of 3.2 feet per mile.

THE LOWER REACH.

From the town of Cascade the character of the river changes to a remarkable degree. The mountains have retired from both sides of the stream, which spreads itself to twice its former size.

The channel is obstructed occasionally by islands covered with cotton wood and willow, increasing its total width in places to one-half mile.

The river is now running through high rolling plains with extensive bottom lands and with so gentle a current that this, the lower, reach has been designated the Long Pool. It extends from the foot of Cottonwood Ripples, 1 mile below Cascade, to the head of the rapids of the Great Falls, immediately at the town of Great Falls, a distance of 54 miles.

Its course is very crooked over this stretch, the distance by rail between these two points being 29.3 miles. The fall of the river over this reach of 54 miles is 27.2 feet, a rate of one-half foot per mile.

The gravel beds have been forced by the current down into tho pool for about 3 miles below Cascade, where they have been dropped and are succeeded by sand bars very much of the same character as those in the lower reaches of the river, although the material is somewhat coarser.

The river begins to show its characteristics even here, cutting the banks to some extent and forming bars here and there, the latter more especially at the approach to the sharp bends, and also where the stream is widened by the islands.

These bars in places have choked the channel to such an extent that navigation is only possible at the higher stages of the water.

They are the only detriment to the successful navigation of the Long Pool.

For the greater part of way there is a free and unobstructed channel with a depth of from 4 feet to 20 feet at low water and from 300 feet to 1,000 feet wide.

SURVEY OF OBSTRUCTIONS IN LONG POOL.

I was commissioned by you on August 31, 1894, to proceed to Great Falls, Mont., and to go over that reach of the river known as the Long Pool, to note the existing obstructions to navigation, and to commence the construction of such a plant as would be most suitable for clearing the channel.

I left Sioux City, Iowa, on the date above mentioned, reaching Great Falls on September 4, and the next day, in company with Capt. J. D. Taylor, of Great Falls, started up the river on his steam launch, but could not get above 5 miles on account of the obstructing bars.

We returned and went by rail to Cascade, coming down from there in a skiff and noting the obstructions on the way.

It was discovered from this rough examination that, owing to the shifting channel, the recorded soundings on the Missouri River Commission maps published in 1891 were no longer reliable.

No authority having been received to begin the building of the plant, I, by your instructions, organized a small party and on the 22d of September proceeded by rail to Cascade; from there we came down to Great Falls in row boats, making hydrographic surveys of the obstructing bars on the way.

These examinations were made as follows: A base line would first be established on an adjacent bank parallel with the stream and covering the extent of the bar. This base for convenience was numbered in stations 100 feet apart; offsets were then made from each station at convenient angles extending across the channel; these offset courses would be followed by two men in a boat, who took soundings at certain intervals, at the same time giving stadia readings. In this manner the entire

channel would be cross-sectioned and soundings noted within every 100 square feet; thus the extent and contour of the bars were accurately located.

There were eight places examined, and for convenience they were numbered from Great Falls up the stream.

Immediately at the foot of the Long Pool the river begins its descent over that reach known as the Great Falls, falling in a distance of 11.4 miles from the first rapids to the fall known as the Great Falls 412.5 feet.

The first obstruction above Great Falls, Island No. 169, is 1.5 miles above the head of the rapids. The river here is spread by the island to a width of 2,100 feet. The main channel runs to the east of the island and is about 1,100 feet wide. The current, which runs strong on the east shore, strikes a low sandstone ledge about opposite the center of the island. The whirlpool thus formed has caused the sand to be deposited at the head of the chute. There is at present a narrow channel through the bar with the depth of 5.5 feet at low water, but it is liable to close. The west chute is choked with a bar at the head of the island. The water there is about 1 foot deep at the low stage. There were also four piers or cribs filled with stone obstructing the east channel. They had formed part of a boom for catching logs; but it having broken, the abandoned piers were left standing.

Bar No. 2 is at the White Bear and Wickner islands, 3.5 miles above Great Falls. The river here is spread to the width of one-half mile. The main channel is between the two islands, but the entire stream was choked by a bar extending from the head of White Bear entirely across the channel above Wickner Island. The bar, which averaged 600 feet across, had 2.5 feet of water over it at the extreme low stage of 1889.

Bar No. 3 is opposite Fox Island, No. 163, situated 4.5 miles above Great Falls. There is but a narrow chute on the east side of the island; it carries but little water at the low stage. The main channel is on the west side and is 1,200 feet wide. The current sets against a rocky point opposite the lower end of the island, and the river in cutting out the west shore immediately above has formed a bay. The water setting back from the rocky point has caused the sand to settle in the bay, forming a bar extending entirely across the channel. . There is about 2.5 feet of water over its lowest point during the low stage. The bar is 1,300 feet wide.

The fourth obstructing bar is at Westcott Island, No. 161, 8.5 miles above Great Falls. The river here averages one-fourth of a mile wide. There are bars at each end of the island which entirely obstruct the channel during low water. The upper one is 809 feet across, the lower one 600 feet. The upper bar has 2.5 feet of water over it at low stage, the lower one 1.5 feet. The main channel runs to the west of the island and is 500 feet wide. The east chute is 300 feet wide and is quite shallow, being nearly dry during low water.

Griffin Bar, the fifth obstruction, is located 1 mile below Island No. 156, or immediately above where Island No. 159 was situated in 1891, but which has since been washed away. The main channel at that time was on the right side, but it has since shifted entirely across the river's bed, and its former course is now occupied by a low flat bar. This bar extends entirely across the channel and obstructs it for 600 feet, the depth of which is 1.8 feet at low water.

The bar is caused by the extreme unobstructed width of the river, which here averages 800 feet, leaving but little available depth. The river at this point and for 3 miles below may require considerable riprap work to force it to clean itself, as it maintains the unobstructed width of from 600 feet to 900 feet with a comparatively gentle current, it being situated within that reach known as the Big Bend.

Thurman Bar, the sixth obstruction, is 36.5 miles above Great Falls. It is situated immediately above a sharp bend of the river and in the vicinity of Island No. 145. The material forming it apparently comes from a cut bank 1.5 miles above.

The river is unobstructed by islands and is 650 feet wide.

The bar partially obstructs the channel for 4,000 feet. At the upper end and again near the center it extends entirely across, obstructing the channel at each place for about 500 feet. The depth at these latter places was 2 feet at the low stage of 1889.

The channel over this bar is very crooked, which makes it difficult for a boat to get through even at an ordinary stage of water.

Cascade Bar, the seventh obstruction to navigation, is at the Cottonwood Ripple, the head of the Long Pool, 54 miles above Great Falls, and consists of a bed of cemented gravel overlaid by a gravel bar. It would necessitate dredging and might require blasting to effect its removal.

There is 2.5 feet of water over the ripple at the low stage. The channel here is 400 feet wide and is unobstructed by islands. The current is quite strong. The bar extends upstream to the wagon bridge 1 mile above opposite the town of Cascade, but does not totally obstruct the channel the entire distance.

Immediately below the bridge the channel is divided by Island No. 122; both chutes carry considerable water; the east one, however, is the main channel.

There are other places in the Long Pool, especially near the islands, where the channel has a tendency to choke with sand; but at the time the surveys were made

there was still sufficient waterway over the bars for successful navigation at low water.

The surveys were finished on October 22, 1894, and the platting then begun was carried forward during the winter as the opportunities would permit.

CONSTRUCTION OF PLANT AND REMOVING PIERS.

From the character of the obstructing bars in the river and the tendency of the channel to shift when obstructed, it was decided that a system of riprapping, the plans of which were sent me from your office, should be constructed, closing the chutes in the rear of the islands at places examined by dams and narrowing the main channel by dikes, which would cause the current to scour out the bars in the main chute to the required depth of 3 feet or more at extreme low water.

I accordingly made plans for a plant for riprapping. It consisted of two stone barges, each 12 by 50 feet, and two brush boats 8 by 30 feet. Afterwards a barge 10 by 47 feet was purchased and added to the plant; it was decked with a 16-foot platform and was to be used as a mattress boat. There were two 6 by 6 inches by 16 feet spuds fastened one on each side of the deck forward and another 4 by 6 inches by 16 feet in the rear. There was an outrigger built from the forward end, which consisted of 3-inch planks surrounding a space 16 by 24 feet and held up by tie-rods running from the outer end over the support posts for the spuds and down to the deck in the rear. By the use of a block and tackle fastened to the outer end of the outrigger the mattresses, 14 by 20 feet, to be constructed on horses, set on the deck of the boat, were to be pulled forward into the water by the aid of a winch fastened to the rear spud supports.

On December 10, 1894, authority was received from you to ask for bids on lumber and hardware for building the boats, should I deem it advisable to begin the work in midwinter. From the fact that carpenters could be hired cheaper during the winter months, and as it would be an advantage to have the plant ready, that operations might be started immediately after the ice moved out in the spring in order to accomplish as much work as possible before the high water of June, it was decided to begin building the plant at once. Accordingly invitations were sent out to lumber dealers and hardware firms to ask for bids on the material.

The lumber dealers were asked to bid on native pine or Oregon red fir. The invitations were issued on December 11 and opened on December 22. The bids ranged from $16.73 per M for native lumber to $29 for the red fir. After some hesitation I recommended the acceptance of the Holter Lumber Company's bid of $16.73 per M for native timber. The hesitancy was caused by the doubt of the fitness of native timber for boat stuff. The bid was accepted, the lumber coming from the west side of the range from near Bonner, Mont.

The native lumber has proved excellent for boat material, being exceedingly tough and of a clearer grade than had been expected.

The lumber began to arrive on the 5th of January and two men were set to work building sheds and rigging a scaffolding on which to build the boats. The boat material came on the 15th and a force of eight carpenters, under Mr. Lewis C. Hicks, began boat building. The lumber received amounted to 20,436 feet, B. M.

The weather remained favorable for the work until February 5. It became so stormy then as to make it impossible to do carpenter work outside and the force was laid off.

On the 11th of February a force of eleven men with a team and a hand derrick was set to work taking out the piers at Great Falls Island, it having been considered cheaper to do this through the ice in the winter than at any other time. The three principal piers in the channel were removed, but the fourth and last one not disturbed, the ice having become so rotten as to make it unsafe to attempt its removal. It sets well up on the bar, however, and being a shallow affair can be easily taken out at any time. This work was abandoned on the 22d of February and boat building, which had been suspended since the 5th, was again renewed.

The boats were finished on the 18th of March and the carpenters set to work building rowboats, tables, bunks, etc., and putting up a coal shed.

They finished their work and were discharged the last of March.

The ice, which had been very rotten since the last of February, began to move out on the 24th of March and by the 27th the river was running clear. Preparations were then made to get the outfit to Fox Island, in the vicinity of the first riprapping to be done.

The ice in the Long Pool does not go out with a rush, as is the case in the lower river, but gradually melts, leaving but little to run off, so there is small fear of any improvement work being damaged by the break-ups in the spring.

CONSTRUCTION.

Capt. J. D. Taylor's steam launch, the *J. J. Hill*, having been chartered without crew for the season, she was put in service the 29th of March, and the camp outfit, which had arrived from Sioux City, Iowa, was taken to Fox Island and the camp

established. On April 1 a force of 35 men was hired and the riprap work started, with Mr. F. L. Walker as foreman. The crew was divided as follows: 8 men, including the foreman, weaving and sinking mattresses; 12 men, including the subforeman, blasting rock and loading stone barges; 9 men, with subforeman, cutting brush and poles, making fascines, and loading brush barges; 3 men on the tender and 3 men in camp.

Work was commenced on the dam across the chute in the rear of Wickner Island, No. 165, and continued there and on the dike out from the point on the opposite side of the island until May 9. The dam was finished, as was supposed, on that date, the crest being 3 feet above the low-water mark of 1889. The force was then put to work on the dam and dike at the head of White Bear Island. The latter construction was finished on June 11. The Wickner Island Dam having settled in the meantime it was decided to put another tier of mattresses entirely across the chute. This work was started on the 13th and finished on the 19th instant.

On the 18th instant work was commenced on the dam across the chute in the rear of Fox Island, No. 163, and at present is about one-half finished. These dams and dikes have been built after the plans sent me from your office. They consist of mattresses weighted with a layer of stone 12 inches thick. Mattresses consist of fascines, each 20 feet long and 12 inches in diameter. The fascines are laid on three transverse poles of the length equal to the desired width of the mattress. Upper transversals consisting of two fascines are laid on the mattress directly above the lower transversals and bound to the latter by annealed wire ties passing through the mattress. No. 12 wire was used in tieing the mattresses and No. 14 in binding the fascines. These mattresses are laid and covered in tiers one above the other until the required height of the dam or dike is reached. The second tier overlaps the upper end of the first 10 feet and each succeeding tier sets 4 feet back from the one below. The dikes are built with a crosshead 100 feet long at the outer end. The mattress boat was used in launching the mattresses in deep water and has worked very satisfactorily. Wherever the water was shallow enough to permit, however, the work has been expedited by weaving the mattresses in the water at some convenient place above the dam. They are then fastened in 40-foot lengths to the side of a loaded stone barge and by the aid of the winch the whole affair is let down to the proper place in the dam from the mattress boat anchored above. Under favorable conditions the crew of eight men will weave, lay, and cover about 80 linear feet of mattress a day. After a dam has been brought to the required height the crest and upper side are well covered with spalls.

Below is a list of dams and dikes constructed up to date and the amount of material in each:

Dam or dike.	Total length.	Linear feet of single mattress laid and covered.	Material used.		Crest above low water, 1889.	Remarks.
			Brush and poles.	Stone.		
	Feet.		*Cords.*	*Cu. yds.*	*Feet.*	
Wickner Island Dam	430	1,310	175	754	4	
Wickner Island Dike	180	280	42.5	201	2.5	Total length does not include head.
White Bear Island Dike and Dam.	545	1,550	185	955	5	
Fox Island Dam	.....	380	36.5	138	.....	One-half completed.
	1,155	3,520	439	2,048	.....	

The effect of the lower dams has been to raise the water's surface 0.3 in the river above. The scour in the main channel due to damming the chutes has become apparent already. The depth there at present is from 3.5 to 10 feet at low water. The most marked change is immediately in front of and below the Wickner Island Dike, where a former bar was exposed in low water. The depth there at present is from 5 to 10 feet. The dams have begun to choke with sand and there are bars forming in the chutes immediately below each one.

The material used in construction has cost the Government nothing, as the stone and the greater part of the brush have been taken from school section 36, Township 20 N., 3 E., the quarry and timber privileges having been granted by the State board of land commissioners.

The labor performed has been paid for by the month, the rate being $30 and $35, with subsistence.

The weather has been very favorable for carrying forward this work since April 1, there having been but three days lost on account of rain.

The greatest drawback has been the almost incessant wind.

The rise of the river this year has been peculiar, coming up the latter part of April to the 3-foot stage and holding between that and the 4.5-foot mark until the present time. In consequence the work has not experienced that usual interruption caused by the high water in June.

NAVIGATION ABOVE THE GREAT FALLS.

The navigation of the Missouri River above the Great Falls is confined to the few months of the high water, as the boats, with one exception, are built on lake models and draw considerable water.

List of steamers plying on the Missouri River above the Great Falls.

Name.	Where built	Year.	Dimensions.			Draft, light.
			Length.	Beam.	Depth.	
			Feet.	*Feet.*	*Feet.*	
J. J. Hill	Racine, Wis	1892	50	10	4½	3
Minnie	Great Falls, Mont	1892	50	10	4½	3½
Francis	do	1892	29	7	3	2½
					Inches.	*Inches.*
Rose	Dubuque, Iowa	1886	44	10	33	13

Name.	Propelling power.				Screw or wheel.	Owners and where operating.
	Boilers.		Engines.			
	Kind.	Steam pressure allowed.	Cylinders.	H. P.		
		Pounds.				
J. J. Hill	Upright, 7½ by 4 feet.	170	Double, 6 by 6 inches.	25	Twin screw.	J. D. Taylor, in the Long Pool.
Minnie	do		Single, 7 by 9 inches.		Single screw	J. W. Cornelius, in the Long Pool.
Francis	Horizontal, 38 by 48 inches.		Single, 5 by 6 inches.	6	do	Klepetco, in the Long Pool.
Rose	Marine pattern.	170	Double, 6½ by 20 inches.	24	Stern wheel.	N. Hilger, Gates of the Mountains.

The traffic on the Long Pool is principally in hay and grain. The steamer *Rose* is used as an excursion boat, and operates through the Gates of the Mountains, and as far down as the Bear Tooth Rapids.

With the river made navigable throughout the season there should be considerable traffic on the Long Pool in hay, grain, and wool from the extensive ranches above; in coal from the recently opened fields on Smiths River near its mouth, and in building stone, immense quarries of which crop out at frequent intervals along the river.

Very respectfully, your obedient servant,

EDWIN D. VINCENT,
Assistant Engineer.

Capt. H. F. HODGES.
Corps of Engineers.

REPORT OF MR. W. G. PRICE, ASSISTANT ENGINEER.

PIERRE, S. DAK., *July 1, 1895.*

SIR: I have the honor to submit the following report of the work at Pierre, S. Dak., for the year ending June 30, 1895.

In September, 1894, a survey was made to determine the recent changes in the banks and bed of the river in the vicinity of Pierre and Fort Pierre, and plans of the plant required for the work were completed. During October and November plans of the proposed dam and dikes were completed. In January contracts were made for the delivery of piles, stone, lumber and other material. In April a supply of willow brush and poles was contracted for, and in June a contract for a further supply was made.

The construction of the plant was begun at Pierre with hired labor March 14, but, owing to the very slow delivery of material by the contractor, it is not completed.

Several carloads of lumber were rejected as not being of the quality and kind specified in the contract.

The plant will consist of four barges and one pile driver, which will use a Vulcan steam hammer. One barge is completed; another is finished all but the deck, and has been in use since May 28. The other barges and pile-driver hull are nearly completed.

The work proposed to be done under the present appropriation is the construction of Dam No. 3 across the chute at Marion Island, five pile dikes at Fort Pierre, having an aggregate length of 1,420 feet, and one pile dike 240 feet long at Pierre 900 feet below the steamboat landing.

The construction of Dam No. 3 was begun May 16 with hired labor, but, owing to the slow delivery of lumber by the contractor, slow progress has been made. This dam is now about three-fourths completed, and a supply of all necessary material is on hand.

It is being built up to high-water mark and consists of a foundation mattress 45 feet wide and 1 foot thick, extending entirely across the chute, on the upstream half of which are placed cribs made of cottonwood poles bound together with spikes and galvanized-wire strand and filled with rock. Three cribs are required 18, 13 and 8 feet wide, respectively, and each crib is 4 feet deep. They are placed one on another so as to make, with the mattress under them and the rock between and on top of them, a total height of 14 feet. The mattress consists of a framework filled with willow brush. The frame is made of two pieces of sawed timber each 1½ by 3 inches by 12 feet, and three upright pieces 22 inches long, each fastened at one end between the 12-foot pieces with a wire nail and wooden pin. After three courses of willow brush, crossing each other, have been filled in, a cap piece, consisting of two pieces 12 feet long, fastened together, with two short blocks of the same material between them, is placed over the upright pieces and forced down with a mat jack with a pressure at every upright piece of 2,000 pounds. The upright piece is then fastened to the cap with a wire nail and a wooden pin. These frames are placed 5 feet apart and they join on to each other end to end so as to make a mattress of any desired size, which is quite flexible. The frames run across the current and project above the willows enough to prevent the round glacial rock, which is used for ballast, from being rolled off of the mattress by the current.

The dikes will consist of a foot mat, as above described, 50 feet wide, with a T head 70 by 120 feet. Two rows of oak piles will be driven 10 feet apart, with the piles 10 feet apart in the rows. Ten piles, spaced 10 feet apart each way, six upstream and eight downstream from the center line of the dike, will be driven to make the T head.

The piles will be tied together with waling pieces of sawed timber and fastened with screw bolts. The dikes will be screened with cottonwood poles, sharpened and driven into the foot mat and nailed to the downstream waling piece.

The transportation of material to the site of Dam No. 3 has been done by the U. S. snag boat *James B. McPherson*, a part of the material being carried on her deck and a part on a barge.

All of the stone required for the work has been delivered; all of the piles, which are of oak, have been delivered except 99, which were seized here by the sheriff to satisfy a claim against the contractor. Nearly all of the timber has been received, so that rapid progress with the work can now probably be made.

Very respectfully, your obedient servant,

W. G. PRICE, *Assistant Engineer.*

Capt. H. F. HODGES,
Corps of Engineers.

REPORT OF MR. F. M. TOWAR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, July 9, 1895.

CAPTAIN: I have the honor to submit the following report of the work under my supervision for the fiscal year ending June 30, 1895:

The work of mapping the survey of Missouri River, from Fort Benton, Mont., to Sioux City, Iowa, has progressed as follows:

The small scale maps (scale: 1 inch = ½ mile) have been completed to the end of the work at Sioux City, twelve having been completed during the year, viz, from Nos. 46 to 57, inclusive. There have also been finished two of the four index maps for this series.

These two cover the river from Great Falls, Mont., to Fort Yates, N. Dak. (Scale: 1 inch = 7 miles.)

Four index maps for the detail charts (that were finished during the previous fiscal year) have also been completed; these cover the entire survey of the river from Fort Benton, Mont., to Sioux City, Iowa. (Scale: 1 inch = 7 miles.)

Lithographic editions of 67 detail charts have been received during the year, of which Julius Bien & Co, New York, have furnished 50; the Forbes Lithograph Manufacturing Company, Boston, 15, and the Heliotype Printing Company, Boston, 2. Of the foregoing series of 198 detail charts there have now been received 181 editions and satisfactory proofs of 7 more.

All that remains now to complete the mapping of the survey of Missouri River from Fort Benton, Mont., to Sioux City, Iowa, is the drawing of 2 of the above-mentioned index maps (scale: 1 inch = 7 miles), the publication of 17 detail charts, and 4 index charts.

THE WORK OF IMPROVEMENT AT SIOUX CITY.

A project was submitted for this work shortly after the passage of the river and harbor act of August 17, 1894, and very promptly approved, but nothing was done last fall, for the reason, it was thought before the necessary plant could be provided it would be too late in the season to complete the work; also that during the winter boats and barges could be constructed and repaired much more cheaply and be completely ready for work during the low water that follows the spring rise. This proved true. The work was commenced with a full force April 5, 1895, and completed May 18, 1895.

The work was done by hired labor, except the piling and brush cutting.

A contract was made for piles in place at a cost of 33.4 cents per linear foot.

The work the present year at Sioux City consists of two newly constructed pile dikes, Nos. 10 and 11, and the repair of two old ones, Nos. 3 and 5, the latter constructed under the direction of the Missouri River Commission in 1889; and the preparation for and commencement of more extensive works, to be completed during the next fiscal year, on the city front about 2 miles above the completed work.

The following description of Dike No. 10, together with accompanying drawings, gives the general methods of construction followed in all:

Dike No. 10 consists of two rows of oak piles running out from the shore normal to the current of the river; there were 15 piles in each row, driven 10 feet apart between centers, the rows being 10 feet apart between adjoining piles.

At the end of these two rows a T head is formed by driving two rows of piles at right angles to the main dike; these rows are 10 feet apart and the piles in each row are spaced 10 feet between centers, extending 20 feet above and 30 feet below the dike and parallel with the current.

The object of this T head is to prevent scouring around the outer end of the piling in the main dike, it being observed that in the case of the dikes built here in 1889 a fill could not be made generally nearer than 25 feet from the outer end of the dike, and in more than one-half of the cases not less than 50 feet.

The foregoing plan proved decidedly successful in all four cases. Sand bars are out of the water around the outer ends of two of these dikes at the present stage of water (6 feet above low water), and a fall of 2 feet will leave the other two in a like condition. These good results have occurred, notwithstanding the present season has been unfavorable for sand deposits, as the water has at no time reached to within 4 feet of the usual high water of the June rise.

The piles were driven to a penetration of not less than 20 feet. The downstream row of piles were braced with longitudinal waling pieces of 6 by 8 inches with pine, the upstream row similarly braced with 4 by 6 inches walings of the same material. The cross bracing between adjoining rows were 6 by 6 inches white pine.

The waling pieces and cross braces were bolted through each pile with three-fourth-inch bolts with nuts 2 feet below the top of the pile.

The tops of the piles have a slope from 16.2 feet above low water at the bank to 13.2 feet at the outer pile, as shown by the accompanying drawing.

The piles are protected from scour by a woven foot mattress of willows, 1 foot thick and 50 feet wide, extending an equal distance above and below the axis of the dike.

The mattress for the T head is 80 feet normal to the current (extending 40 feet beyond the outer row of piling) and 120 feet parallel with the current extending an equal distance (30 feet) beyond the upper and lower piles in the T head.

The mattress was woven with a selvage edge extending around its entire area. In this selvage were woven two strands of three-eighths-inch wire rope. Three single strands of five-eighths-inch wire rope were woven through the body of the mattress for the entire length of the dike. Single strands of three-eighths-inch rope extended across the mattress from one side to the other every 10 feet, fastened at either end to the cables in the selvage.

The shore end of the dike is graded to a slope of 3 on 1, the foot mattress extending to the top of the bank.

The foot mattress was weighted with broken pieces of stone weighing from 15 to 150 pounds each, one-half of a cubic foot of stone being placed on every square foot of the dike except on the slope at its root, where 1 cubic foot of stone is used to every

square foot of mattress. The T-head mattress was covered with a cubic foot of stone to each square foot of mattress over its entire area.

The dike was screened in the following manner: Willow poles 3 inches in diameter were driven into the mattress, from 6 to 8 inches apart, along the lower row of piling and spiked to the 6 by 8 waling near the top of the pile; a second waling was used, spiked to the piles 7 or 8 feet below the upper one, to give additional strength to the screens and furnish a bearing for them in case the bearing in the mattress was lost by scour.

Upon the completion of the work on May 18 the working crew were all discharged.

On May 21 a small force was employed to commence the construction and repair of additional plant for the more extensive work up the river.

The work done has been the complete overhauling of the little steamer *Josie;* both her hull and machinery have been thoroughly gone over. The repair of the large barge built in 1881 has made it nearly as good as new.

Ways were constructed on two of the barges, bolted together end to end, for use as a mattress barge, making a boat 108 feet long.

Lumber for the dikes and the new 100-foot mattress barge was delivered here by railway, at the levee, loaded on barges, and towed to the Big Sioux River by the *Josie.*

Work was at once commenced on the new barge, which I confidently expect to have in service between the 15th and 20th of the present month.

The following material was used in construction of the dikes:

Oak piles		126
Brush	cords	444
Broken stone	cubic yards	1,800
White pine braces	feet, B. M.	8,662
Bolts, with nuts and washers		274
Three-eighths inch wire cable	linear feet	11,000

DISTRIBUTION OF EXPENSES.

Engineering, etc	$850.27	
Plant	375.03	
		$1,225.30
Construction of mattress.		
Brush bought	328.56	
Loading, towing, and unloading brush	282.39	
Weaving	980.11	
Wire cable	140.00	
		1,731.06
Piling in place	1,467.86	
Lumber for bracing piles	180.00	
Screening poles	20.00	
Labor	210.88	
		1,878.74
Weighting mattresses.		
Labor unloading rock from cars	103.00	
Labor placing rock on mattress	1,149.13	
Purchase of rock	3,402.64	
Hire of barge	37.00	
		4,691.77
Miscellaneous expenditures		341.13
Reserved for liabilities		132.00
Total		10,000.00

Very respectfully, your obedient servant,

F. M. TOWAR, *Assistant Engineer.*

Capt. H. F. HODGES,
Corps of Engineers.

REPORT OF H. C. GOULD, ASSISTANT ENGINEER.

MANDAN, N. DAK., *July 1, 1895.*

SIR: I have the honor to submit the following report on ice harbor at Rockhaven, N. Dak., water gauges, Bismarck Harbor protection, etc., during the year ending June 30, 1895.

ICE HARBOR AT ROCKHAVEN, N. DAK.

The grading of the bank on the upper half of the harbor, which had been suspended June 30, 1894, on account of high water and delay in obtaining title to lower half of the land needed, was gradually resumed late in July, and continued as the river went down till about October 15.

The high water left a large deposit of mud and silt all over the low flat which had been partly graded down before the rise, the fill varying in depth from 1 foot to 4 feet. Its removal with scrapers was slow and difficult, as teams could not go on it until partly dried out.

The amount excavated by scrapers, shovels, and wagons is 15,904 cubic yards; 123 yards of rock was taken out.

During the suspension of the grading in July the small barges, the large barge with engine on it, the store boat, and quarter boat were removed to near the proposed boat yard at lower end of harbor.

The mooring posts were filled with concrete, the surplus broken stone removed, the platforms and bins taken up, and material stored.

Cross sections were sounded along the whole harbor front, and borings were made near the proposed new low-water line to a depth of 4 feet below low water, to ascertain if any rock would be met in dredging to that depth, but none was found.

The corners of the Government tract were marked by permanent monuments, a number of surplus stones and iron pipes left from the river survey being used for this purpose; the lettering and markings pertaining to surveys were removed from the stones and pipes, and they were set in the same manner as for survey stations.

The snag boat *Josephine* commenced work at the harbor September 5, sluicing with her wheel to increase the depth and cut back the shore line along front of the work. Her work was very efficient. During the first two days a cut 1,400 feet long, 35 feet wide, and 5 feet deep in middle was made through a low mud flat only a few inches under water and lying just below the grading, in order to give a better outlet for the sluicing to be done above. Sluicing was then started at the head of the harbor and carried down along the whole front of the present grading.

In operation the steamboat is placed against the bank, with head upstream. A line leads some distance down the bank to hold the boat from going ahead; one of the spars is set to hold the bow out, and the stern is held close in by the line directly to the bank. The wheel is then run as if going ahead, thus throwing a strong current of water against the bank and bottom, cutting it away to sometimes 300 or 400 feet below the boat. At places a bank 5 feet high was rapidly cut away and a depth of 5 feet obtained; at other places, where the shore was composed of sticky gumbo, the erosion was very slow.

The *Josephine* also removed a large part of the old crib and the wreck of the *Undine*. She left the work September 21 for a snagging trip; returned again October 11 and remained until the close of the work in November, being occupied in sluicing and removing old crib and wreck of *Undine*. These obstructions were removed to a depth of 3 feet.

The rock obtained in grading the bank and dumped at upper end of the work was used in building a short dike to throw running ice away from the new graded shore line. The foot of the dike is at low-water mark; the outer end is cone shaped, sides rising at an angle of 45°, and radius at low water is 55 feet. The larger rock was laid in rough riprap courses on the surface and the remainder used for filling inside. The rock on hand was sufficient to build the dike at 15 feet above low water. It will be built next year to the top of the bank, or 24 feet above low water.

To keep the edge of the embankment in front of mooring posts from being worn off by steamboat lines, pine timbers, 6 by 16 inches, were obtained, dressed to shape, thoroughly painted all over with mineral paint, and set in the edge at every post, extending 20 feet both sides of the posts.

A number of the surplus iron survey-station pipes, with cast-iron caps, were set 4 feet apart in rows along sides of the approaches to top of the embankment, to prevent driving over edges and corners of the approaches. The tops of the posts are about 1 foot above the ground, and will be painted white.

At the close of the season's work in October the bank grading was completed to 1,500 feet below the head dike, and the dredging (by steamboat sluicing) had made an average depth of 4 feet in front of this portion at stage of 2.4 feet.

The snag boat *Josephine* laid at the harbor through the winter. The efficiency of the work done was fully proven in the breakup of the river this spring.

During the winter the title to the lower half of the ice-harbor tract was obtained. It is expected to commence work in July to complete the grading on this lower part and a grade for hauling-out ways and boat yard at lower end.

MISCELLANEOUS WORK AT ROCKHAVEN.

A shed was built on one of the barges to protect the hoisting engines and other property for which there was not room in the store boat. The shed is 40 feet long, 15$\frac{3}{4}$ feet wide, with sides 8 feet high.

One of the hoisting engines was fitted up and placed in running order by the *Josephine's* engineers, to be sent to Pierre in the spring.

Watchman Kelly's house was repaired by relaying part of the floor, taking off and rearranging the roof over rear part, using second-hand lumber, providing two storm windows, and building a full shed in front.

An ice house was built at the upper end of the Government tract by making an excavation in the bank 16 by 24 feet and 9 feet deep, lining sides and ends with sawdust, and putting on a substantial roof covered with dirt.

The house was filled with good ice by the watchman and a few men hired for the occasion.

The free use for the winter of one of the boarding "shacks" was obtained, and it was fitted up for the *Josephine's* watchman by placing tarred paper on the roof, laying floors, putting in double doors and windows, and building thick sod walls all around.

A permanent dwelling for the regular watchman at Rockhaven was planned during the winter and authority obtained for its erection, at a cost of not exceeding $1,000. The house has two stories and six rooms; main part 30 by 18 feet, and ell 12 by 6 feet, sides 16 feet high.

Rock for the foundation was taken from the ice-harbor grading and hauled to the site last summer. Lumber and other material were purchased on bids in March and May. The foundation walls were laid in June, cellar excavated, outside frame and floor joists put up, and outside sheathing started.

CEMENT TESTS.

In July and October I made a number of pats for testing time of setting, and 256 briquettes from samples of the Yankton cement used in making anchor blocks for the mooring posts. They were placed in galvanized-iron boxes and all packed in a box filled with water and sent to Sioux City. In November some of the briquettes six weeks old were broken, and in January some six-month's-old briquettes were broken. Your instructions are to make one-year and two-year tests on the briquettes and then compile a detailed report of the whole.

WATER GAUGES.

Townsend, Mont.—The regular weekly reports were received all the year, by direction of the secretary of the Missouri River Commission.

Fort Benton, Mont.—This gauge was in operation all the year. The gauge was examined by me and zero tested August 1 by leveling from bench mark in courtyard. The zero was 0.2 low and was corrected.

Wolfpoint, Mont.—Readings were continued until the river closed, November 24, 1894, and were resumed after the ice went out, March 28, 1895.

The zero was tested by me August 7, 1894, and found to be practically correct.

The movable iron-beam cable gauge, which was on trial at Sioux City at the last report, was sent to this place, set up by Mr. C. A. Swift, and readings started October 4, 1894. Its operation has been satisfactory.

Fort Buford, N. Dak.—Readings were stopped when the river closed, November 18, 1894, and were not resumed until the new gauge, described below, was set up on April 24, 1895, by Mr. John Wade.

The zero was tested August 10, 1894, and three new bench marks set near the gauge. The zero was 0.25 low and was corrected.

Bismarck, N. Dak.—The readings were continued all the year.

Pierre, S. Dak.—No readings were received from the Weather Bureau gauge. One of the new gauges described below was set up by Assistant Engineer W. G. Price, and readings started April 24, 1895.

Running Water, S. Dak.—The readings are continuous, except from December 29, 1894, to March 19, 1895, when the river was closed.

On April 13, 1895, one of the new gauges described below was placed in operation by me, assisted by Mr. John Wade.

Sioux City, Iowa.—Copies of the readings were received all the year, by direction of the secretary of the Missouri River Commission.

Miscellaneous.—The records were copied as usual and hydrographs kept up during the year.

The movable iron-beam cable gauge that was placed on trial at Sioux City last year worked very well, but was thought to be too heavy and expensive.

Another gauge, operating on the same principle, but different in form, was designed during the winter. Cast-iron chairs are set on six heavy posts placed 12 feet apart in a line normal to the river bank. These chairs carry a level track made of 4-inch steel I beams in sections of 12 feet. On the track is placed a four-wheeled carriage, built by securing common crosses on each end of 3-inch iron pipe 9½ feet long, with short pieces of 3-inch pipe in the four side openings of the crosses and caps on the

ends of the short pieces. The wheels, 12 inches in diameter, are placed against the caps on axles which run through the caps and crosses. On the forward axle an upright post, 7 feet high, made of two pieces 2-inch T steel, is placed with guy from its top to rear axle. The forward axle of 1-inch pipe extends 4 feet outside the wheels, and from the ends guys run to the rear axle. An extension of iron pipe 33 feet long is attached to the front opening in forward cross; the first three pieces are of 2-inch, 1¼-inch, and 1¼-inch pipe, respectively, each 10 feet long, and the outer piece, 3 feet long, is of 1-inch pipe. From each joint of this extension small iron guys extend to the top of the upright standard and to outer ends of the extension of forward axle. A deep-grooved sheave, 5 inches in diameter, is placed on outer end of the pipe extension, over which runs a three-sixteenths-inch iron-wire sash cord having a 16-pound sash weight at lower end and an adjustable index pointer and handle at the other end. A wood scale board about 20 feet long is secured on top of the axles and graduated to feet and tenths. The rear wheels are cast solid and wider than the forward wheels for counterbalance, and about 50 pounds of lead is run into the rear axle for same purpose. Wood blocks were bolted to each end of the track to keep carriage from running off, and a chain, with padlock, is provided to secure the carriage to track when not in operation.

Readings are taken in same manner as with the standard cable gauge on bridges, after running the carriage to outer end of track. As the track is level the gauge will read correctly in any position on the track when the weight will reach the water. If the bank becomes liable to cave away the keeper removes the outer section of the track and the chair.

The order for building three of these gauges was given to the Gillette-Herzog Manufacturing Company, of Minneapolis, after bids on circular notices, for $110 each for delivery f. o. b. cars at Minneapolis. I inspected them March 28, 1895, and found them to be exceedingly well made. They were sent to Fort Buford, Pierre, and Running Water, as noted in foregoing.

BISMARCK HARBOR PROTECTION.

During parts of August, September, and October a survey was made, in accordance with your instructions, extending from the upper end of the Government tract at Rock Haven to nearly a mile below the Bismarck river landing. A base line was carefully measured from B. M. $\frac{1}{14}$ to upper boundary post. A system of tertiary triangulation was run from the base line to a bench mark of the Missouri River survey near Bismarck. Azimuth was taken from the lines Mandan to Harmon and Mandan to Lincoln, these being stations in the secondary triangulation done by the Missouri River Commission in 1889.

The angles were read with a Brandis transit and triangles computed. The shore lines and bars were run by stadia, connecting with the tertiary triangulation stations.

Soundings were taken with the aid of the *Josephine's* yawl, and the ends of the lines were located by stadia.

The work was platted on a scale of 1 inch to 600 feet, and contours of 3 feet and 6 feet depth drawn in; the shore lines were also platted and lithograph sheets of the 1891 survey of the river, scale 1 inch to 1,000 feet, the characteristic soundings transferred to them, and the contours of 6 feet depth put on. The maps were sent to the office October 26, 1894.

In November and December I made estimate of material and outfit required for carrying out this work in accordance with your project. On account of delay in approval of the project only circular notices for bids were issued. Bids for furnishing 700 piles were opened March 25, and the order given to Charles King, Tacoma, Wash., whose bid was 3.72 cents per foot f. o. b. cars at or near Tacoma.

Bids for furnishing about 135,000 feet of lumber, 4,100 cubic yards stone, bar iron, bolts, nails, wire ropes, manila rope, tackle blocks, pile hammer, and other materials were opened May 26.

The order for lumber was given to the Calhoun Coal and Lumber Company, Kansas City, Mo., who bid to furnish fir lumber at or near Portland, Oreg., but failed to deliver on time and their order was canceled. The lumber was then purchased in open market of Inman, Poulsen & Co., Portland, Oreg., at lower prices than the bid first accepted, being $6.25 per thousand for rough and $7.75 per thousand for dressed lumber f. o. b. cars at Portland.

The order for stone was secured by the Northern Pacific Railroad Company, the lowest bidders, the bid being $1 per cubic yard for stone already piled on the bank near the proposed work.

Mr. E. A. D. Parker was sent to Mandan April 15 to receive materials, make a survey of the shore line at the proposed dikes, and locate them on the ground.

I arrived at Mandan May 4. A temporary office was established in rear part of the State Bank building. Two cars lumber had arrived May 3, and the iron, bolts, hardware, paint and oils, and pile hammer were already there.

A warehouse 48 by 18 feet, with 10-foot walls, was started May 9 near the middle of the proposed works, and completed on the 16th; an office 15 by 12 feet was made in one end and occupied on May 18.

The use of a track formerly used by the railroad company in bank protection work here was obtained. The material in a number of spur tracks on the site was taken up and used with other material furnished by the railroad company in extending this supply track to the upper end of dike work.

The lumber, piling, and other material arrived promptly. The boiler, pipe fittings, etc., sent from Sioux City arrived safely at Bismarck and were delivered at the works by the *Josephine* May 17.

The construction of the pile-driver hull was commenced May 16. It was launched June 8. The machinery was moved on board, set up, and connected; the leads were framed, set up, and hammer put in. A pile was driven for trial June 22 and the machinery found to work satisfactorily, except the friction drum on the hoist engine, which required some minor repairs. The house over boiler was built and painted; the leads were also painted all over.

On June 25 the driver was moved to upper end of works and two mooring piles driven above Dike No. 1; two more were driven on the 26th. The crew were occupied the rest of the month in fitting up the driver with capstans, roller chocks, fuel bin, vise bench, blocks, etc.

The crew and tools of the snag boat *Josephine* were used in setting up the pile-driver machinery.

The hull of the driver is 65 feet long, 18 feet wide, and 4 feet deep. The boiler is the Roberts safety water-tube boiler, formerly used on the snag boat *Mandan*. The hoisting engine is one of the old engines brought down from the upper river in 1884; it has a single cylinder 7 by 12 inches and a single drum with winch head on end of drum shaft.

A small open barge 24 feet long, 6 feet wide, and 2 feet deep was built for handling mooring lines.

The 50-foot barge in use at Rockhaven last year was brought down here.

Two of the 56-foot barges and two of the 40-foot barges at Rockhaven were thoroughly overhauled, repaired, and calked and brought down for this work.

Last March nearly 800 cords willow brush were cut by hired labor on the bottom just below the railroad bridge and hauled to near the works.

In June about 750 cords more were cut at the same place and hauled to the works.

Fourteen carloads lumber and eighteen carloads piling were received and unloaded.

DIKE CONSTRUCTION.

Inclines for the land ends of the mattresses were graded on slope of 1 on 3 at Dikes 1, 2, and 3. The brush mattress at Dike No. 1 was built in place from the ground surface down the incline to about 15 feet into the water; a smaller mattress at Dike No. 2 was nearly finished.

Ways on which to build the mattresses before floating them into place in the dikes were nearly completed at the end of the year. They are placed on 2-inch plank laid on an incline of about 1 on 4, graded in the bank about 300 feet above Dike No. 1.

Mr. E. A. D. Parker has been a very efficient and very satisfactory assistant in all of the field work of the year.

Respectfully submitted.

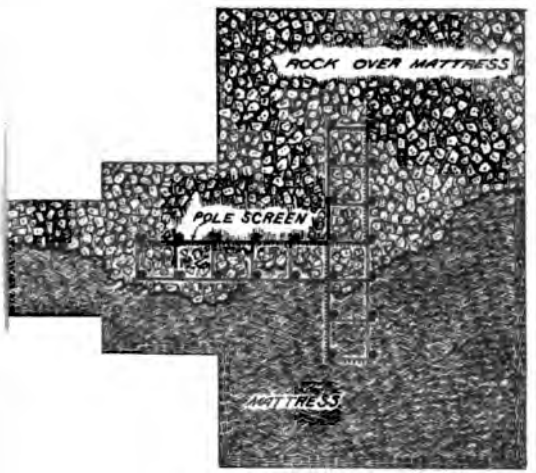
H. C. GOULD, *Assistant Engineer.*

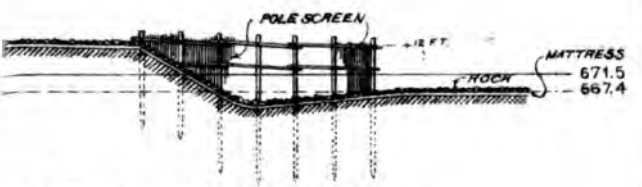
Capt. H. F. HODGES,
Corps of Engineers.

COMMERCIAL STATISTICS.

River tonnage between Sioux City, Iowa, and Stubbs Ferry, Montana, exclusive of live stock.

Year.	Tons.	Year.	Tons.
1887	13,961	1891	13,055
1888	12,895	1892	15,182
1889	16,724	1893	13,837
1890	13,326	1894	25,151





x City Ia. July 10th 1895
cany Annual Report of this date

H. A. Hodges

Captain, Corps of Engineers U.S.A.

Traffic by river reaches.

Year.	River reaches between—	Packages and bulk freight.	Passengers.	Live stock.
		Tons.	*Number.*	*Head.*
1890	Sioux City and Bismarck	9,735	4,322	2,974
	Bismarck and Fort Buford	2,467	184	43
	Fort Buford and Fort Benton	1,124	62	43
1891	Sioux City and Bismarck	10,410	1,749	4,683
	Bismarck and Fort Buford	2,645	130	59
1892	Sioux City and Pierre	2,634	32	6,043
	Pierre and Bismarck	7,247	177	2,315
	Bismarck and Fort Buford	5,301	278	300
1893	Sioux City and Pierre	5,456	12,513	23,137
	Pierre and Bismarck	6,256	137	20
	Bismarck and Fort Buford	2,125	12	2
1894	Sioux City and Pierre*	1,491	3,095	9,258
	Pierre and Bismarck	19,171	16,362	41,356
	Bismarck and Fort Buford	4,461	102	1,849
	Great Falls and Stubbs Ferry	28	903	.....

* Statistics of steamer *Little Maud* not reported, and taken same as for previous year.

List of steamers plying on the Missouri River between Sioux City, Iowa, and Stubbs Ferry, Montana, during the year 1894.

Name.	When built.	Dimensions.			Tonnage.	Manager or owner.
		Length.	Breadth.	Depth.		
		Feet.	*Feet.*	*Feet.*		
Mary E. Bennett	1880	65	14	2	21.71	R. A. Talbot, Sioux City, Iowa.
Capitola Butt	1885	83.7	23.3	3.3	57.31	Do.
Vint Stillings	1881	131	31.6	4.8	177.47	Selzer Bros., Sioux City, Iowa.
Josie L. K	1884	60	14	2.5	22.75	A. Larson, Yankton, S. Dak.
Little Maud	1882	92	20	3.4	58.66	Jos. Leech, Running Water, S. Dak.
Last Chance	1870	98.2	17.8	3	50.47	H. J. King, Chamberlain, S. Dak.
Jas. Leighton	.....	.....	.....	.....	57.29	F. Horn, Pierre, S. Dak.
Castalia	1892	.....	.....	.....	75	B. S. Holmes, Sioux City, Iowa.
Batchelor	.....	178.6	31	4	313	I. P. Baker, Bismarck, N. Dak.
Rosebud	1887	177.4	31.3	4	286.49	Do.
Imelda	.....	90	17	2	Less than 50 tons.	D. B. Weatherbe, Fort Yates, N. Dak.
Rose	1886	44	10	11		N. Hilger.
J. J. Hill	1892	50	10	4.5		J. D. Taylor.
Minnie	1892	50	10	4.5		J. W. Cornelius.
Francis	1892	29	7	3		J. Klepetco.

Dates of ice closings and openings on the Missouri River above Sioux City, Iowa, 1894–95.

[Continued from p. 1748, Report for 1894.]

Locality.	Closing.	Opening.
Montana:		
Townsend	Dec. 29, 1894	Mar. 18, 1895
Fort Benton	Jan. 3, 1895	Feb. 27, 1895
Wolfpoint	Nov. 24, 1894	Mar. 28, 1895
Great Falls	Jan. 1, 1895	Feb. 26, 1895
North Dakota:		
Fort Buford	Nov. 18, 1894	Mar. 29, 1895
Bismarck	Nov. 19, 1894	Mar. 27, 1895
South Dakota:		
Running Water	Dec. 29, 1894	Mar. 19, 1895
Iowa:		
Sioux City	Dec. 28, 1894	Mar. 20, 1895

Z 2.

REMOVAL OF SNAGS AND OTHER OBSTRUCTIONS IN MISSOURI RIVER ABOVE SIOUX CITY, IOWA.

PROJECT.

The approved project contemplates the removal of snags and other obstructions from the Missouri River between Stubbs Ferry and the south line of Sioux City. Three snag boats are maintained for the work, which is done by hired labor.

APPROPRIATIONS.

March 5, 1893	$50,000
August 18, 1894	50,000

CONDITION AT BEGINNING OF YEAR.

Before the date of the first special appropriation the work was carried on under allotments aggregating $192,847.30 from the appropriations for general river improvement. When the first special appropriation became available, on July 1, 1893, there were three boats on hand which had been purchased or built from the general appropriations. The condition of the fleet at the beginning of the fiscal year was as follows:

Snag boat James B. McPherson.—A steel-hulled stern-wheel snag boat, finished in 1891 by the Iowa Iron Works, of Dubuque. This boat is 170 feet long by 36 feet beam, with a nominal capacity of 340 tons. Since the alteration of her stern in the winter of 1893–94 she draws 31 inches with an average load. She has a compound condensing engine. At the beginning of the year she was at work on the river between Sioux City and Chamberlain.

Snag boat Josephine.—A wooden-hulled stern-wheeled snag boat, purchased in 1885 at Bismarck, N. Dak. This boat is 183 feet long by 31 feet beam, with a nominal capacity of 331 tons. She draws 29 inches with an average load, and has single-expansion noncondensing engines. At the beginning of the year she was at work on the river between Fort Yates and Washburn.

Snag boat Mandan.—A steel-hulled stern-wheel snag boat, built in 1891 as a snag scow, without motive power, by the Carondelet Boiler and Sheet Iron Works, of St. Louis, and subsequently altered. This boat is now 138 feet long by 24 feet beam, with a nominal capacity of 150 tons. She draws 26 inches with an average load, and has compound noncondensing engines. At the beginning of the year she was at work on the river between Chamberlain and Fort Yates.

WORK DURING THE YEAR.

The *McPherson* worked from July 1, 1894, until November 1, 1894, except for four weeks lost on account of high water. On November 1 she entered winter quarters at the Sioux ice harbor. On April 20, 1895, she left the harbor and has since been at work on the river between Sioux City and Pierre. A certain amount of time has been used in carrying material for the dike work at Pierre and Fort Pierre.

The *Josephine* worked from July 1, 1894, until November 13, 1894, except for four weeks during high water. In the time thus lost she made a trip to Fort Benton and brought down property which had been left on the bank before the abandonment of work on the Rocky River. On November 13, she was laid up for the winter in the Rockhaven ice

harbor. On April 13, 1895, she resumed work and has been employed since then between Fort Yates and Bismarck. A few days have been used in carrying material for the dike work at Mandan.

The *Mandan* worked from July 1, 1894, to November 4, 1894, when she was hauled out on ways in the Sioux ice harbor and blocked up for repairs. Her plating had been severely injured and several frames had been broken by striking stumps and rocks during the season. It was also necessary to replace her boiler by one better adapted to the work. The repairs were completed in February, but, owing to lack of other funds, it was not possible to build the boiler until the expenditure of the appropriation of August 18, 1894, should have been authorized. This was not done until February 27, 1895. The boiler was then ordered at once and was in place on June 13, 1895, when the boat began work again.

The expenses for the three boats have been $45,899, of which $27,037 have been supplied by allotments from the appropriations for general river improvement, and $18,862 from the appropriations for removing obstructions.

Summary of work of boats.

Boats.	Snags removed or destroyed.	Rocks removed.	Miscellaneous obstructions removed.	Trees cut.	Working days.	Miles run.	
						Up.	Down.
McPherson	304	327	117	30	168	1,017	873
Josephine	316	.....	180	1,855	168	1,485	1,493
Mandan	198	127	11	36	123	884	884
Total	818	454	308	1,921	459	3,386	3,250

WORK REQUIRED.

Until the channel of the river has been permanently regulated and fixed, it will not be possible to clear it entirely of snags. Whenever it shifts, it uncovers old buried snags, or sweeps new ones into dangerous positions. Each year therefore brings new work with it.

The removal of snags and rocks is undoubtedly of greater benefit to the commerce of the river than any other which could be accomplished with the same outlay. The trade on the river is small and the cost of the work is $50,000 annually. Should it be decided to continue the removal of obstructions, this sum should be appropriated.

Money statement.

July 1, 1894, balance unexpended		$4,516.41
Amount appropriated by sundry civil act approved August 18, 1894		50,000.00
		54,516.41
June 30, 1895, amount expended during fiscal year		18,862.00
July 1, 1895, balance unexpended		35,654.41
July 1, 1895, outstanding liabilities	$6,612.36	
July 1, 1895, amount covered by uncompleted contracts	2,600.00	
		9,212.36
July 1, 1895, balance available		26,442.05
Amount (estimated) required for completion of existing project		*50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

*Annually.

Z 3.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

APPROVED PROJECT.

The approved project contemplates rock removal at various places on the river, the construction of closing dams and wing dams at points below Glendive, and a survey of the river. Operations under this project are now suspended.

APPROPRIATIONS.

1878 (allotment for survey from appropriations for examinations and surveys)	$15,000
1879	25,000
1880	15,000
1881	20,000
1882	20,000
1884	20,000
1886	18,750

CONDITION AT BEGINNING OF YEAR.

The expenditures on the river have resulted in giving a depth of 3 feet at the points improved above Glendive and of 3 feet or more at the points improved below that place. The survey has been finished.

OPERATIONS DURING THE YEAR.

During the fiscal year ending June 30, 1895, no work was done. For reasons given in Appendix X 2 of the Annual Report of the Chief of Engineers for 1887, the project is suspended for further action of Congress.

There has been expended on the river improvement a total sum of $103,029.59, and on the survey a total sum of $19,000.

There was formerly a brisk river traffic, which has been killed by the railroads.

Money statement.

July 1, 1894, balance unexpended	$11,720.58
June 30, 1895, amount expended during fiscal year	.17
July 1, 1895, balance unexpended	11,720.41

Z 4.

PRELIMINARY EXAMINATION OF THE NEBRASKA SIDE OF THE MISSOURI RIVER OPPOSITE SIOUX CITY, IOWA.

[Printed in House Ex. Doc. No. 48, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report of November 16, 1894, by Capt. H. F. Hodges, Corps of Engineers, giving results of preliminary examination of "the Nebraska side of the Missouri River opposite Sioux City, Iowa, from a point in Nebraska where an extension of the lower limits of Sioux City, Iowa, would intersect

the Nebraska side of the river and up the river to a point in Nebraska opposite the mouth of Big Sioux River," provided for by river and harbor act of August 17, 1894.

Captain Hodges reports that he considers the part of the Missouri River covered by the present examination worthy of improvement to the extent necessary for the protection of the caving bank between the revetments already constructed on the South Sioux City front. The views and conclusions of Captain Hodges are concurred in by Col. O. M. Poe, Corps of Engineers, the division engineer, and by this office.

No detailed survey is necessary in order to submit a plan and estimate of cost of improvement.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, November 16, 1894.

GENERAL: I have the honor to submit the following report of the preliminary examination of the Nebraska side of the Missouri River opposite Sioux City, Iowa, from a point in Nebraska where an extension of the lower limits of Sioux City, Iowa, would intersect the Nebraska side of the river, and up the river to a point in Nebraska opposite the mouth of Big Sioux River.

This examination was ordered by the river and harbor act of August 17, 1894, and was made by me on the 5th instant.

The lower limit of the ground covered is 2 miles below the bridge of the Chicago, St. Paul, Minneapolis and Omaha Railroad, and the upper limit is 5½ miles above that structure.

For the entire distance of 7½ miles the Nebraska bank is low, although not flooded at ordinary high water.

At present, below the railroad bridge, a sand bar makes out from the low bank and holds the channel near the Iowa side.

About 1,000 feet above the bridge the railroad company has constructed a spur dike, projecting from the Nebraska side, and has revetted the bank for a distance of half a mile above the dike with weighted mattress work, built in the summer of 1893.

The part thus protected is shown in red on the accompanying copy of chart No. 198, survey of the Missouri River.

For about three-quarters of a mile above the termination of this mattress to a point opposite the main part of the town of South Sioux City the bank is unprotected and has been cutting seriously, especially in the season just past. Several houses are reported to have been moved back from the bank, and one has fallen into the river.

From the upper end of this unprotected part to a point 3,500 feet above, the bank has been revetted with a mattress held down by anchors and wire. For part of this distance a pile training wall connected with the bank by short spurs has also been constructed. This work was done in 1890–91 under the auspices of a company formed for the construction of a bridge to cross the river at this point. The bridge has not yet been finished.

From the upper end of the last-named revetment to the upper limit of the examination the shore is unprotected. The present bank is in reality the edge of an island, which extends between the channel and a slough where the main volume of the river formerly ran.

Except opposite the town of South Sioux City, the river between the points named in the act does not demand immediate attention; indeed, nothing short of a systematic improvement by contraction works will be of any material benefit in deepening the channel. At the place mentioned, the bank should undoubtedly be held. The effects of the erosion are felt not only in the destruction of property, but in the shifting of the channel and in the formation of bars lower down, where the eroded material is deposited. If the cutting be allowed to continue there is every reason to believe that it will flank the revetment put in by the railroad company and change the channel in such manner as to cause the current to strike the piers of the bridge obliquely.

The construction of a revetment to protect the caving bank would, in all probability, form part of a project for the general rectification of the portion of the river covered by the examination; there is good reason to hold the channel on the Nebraska side, opposite Sioux City, as the bank there is already protected to a great extent.

The commerce on the upper Missouri River is very small, and has for the last few years shown no marked sign of increase. There is little ground to believe that the execution of any isolated work, such as the rectification of a short reach, will have any noticeably encouraging effect. Nevertheless, a certain amount of such work seems judicious where it is necessary to prevent the channel from growing much worse than it now is, and particularly in places where there is promise of the durability of the single works, and where they can be laid out in conformity to the probable general scheme for river improvement, should this ever be entered upon. Hitherto the town fronts along the river have been considered as the proper points for undertaking the first works.

There are three commercial steamboats at Sioux City which have been idle during the greater part of the past season. There is also a fourth owned at Sioux City but operating on another part of the river.

A total of 5,456 tons of freight, 12,513 passengers, and 23,137 head of live stock were carried on the reach of the river between Sioux City and Pierre in the year 1893.

The radical improvement of the stretch of river included within the limits of the present examination would be a work of great magnitude. The boating interests of the locality are not at present of sufficient importance to warrant me in recommending it. The protection of the cutting bank at South Sioux City is, however, a much smaller undertaking, and may, I think, be justified as a public necessity.

Although I am reluctant to recommend beginning at present any work on the upper Missouri which has not already been ordered or authorized by Congressional action, I consider, nevertheless, that the part of the river covered by the present examination is worthy of improvement to the extent necessary for the protection of the caving bank between the revetments already constructed on the South Sioux City front.

Two charts, numbered 197 and 198, of the survey of the Missouri River are transmitted herewith to show so much of the locality as lies within the limits of that survey.

No further detailed survey will be necessary to lay out the work suggested above. It will be desirable to rerun the shore line and take soundings enough to show the changes which have occurred since the

existing maps were made. The cost of this work is estimated at $100. It should not be done until just before entering upon the work of construction.

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 20, 1894.

Respectfully forwarded to the office of the Chief of Engineers. I concur in the views and conclusions of the district engineer, Capt. H. F. Hodges, Corps of Engineers.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

Z 5.

PRELIMINARY EXAMINATION OF TONGUE RIVER, MONTANA, WITH A VIEW OF STRAIGHTENING ITS CHANNEL ALONG THE EASTERN EDGE OF THE FORT KEOGH MILITARY RESERVATION.

[Printed in House Ex. Doc. No. 75, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 27, 1894, by Capt. H. F. Hodges, Corps of Engineers, of the results of a preliminary examination of Tongue River, Montana, "with a view of straightening its channel along the eastern edge of the Fort Keogh Military Reservation," made to comply with the requirements of the river and harbor act of August 17, 1894.

It is the opinion of Captain Hodges, concurred in by the division engineer, Col. O. M. Poe, Corps of Engineers, and by this office, that Tongue River is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, September 27, 1894.

GENERAL: I have the honor to submit the following report of the preliminary examination of Tongue River with a view of straightening its channel along the eastern edge of the Fort Keogh Military Reservation.

This examination was ordered by the river and harbor act of August 17, 1894, and was made by me on the 18th instant.

In 1890 an examination was made of the same locality by Capt. C. F. Powell, Corps of Engineers. His report, printed in House Ex. Doc. No. 118, Fifty-first Congress, second session, and on pages 2237 et seq. of the Annual Report for 1891 of the Chief of Engineers, was adverse to any improvement of the river by the United States.

The Tongue River flows into the Yellowstone at Miles City, Mont., 187 miles above the junction of the Yellowstone and Missouri rivers. At low water it is an insignificant stream, but at high water the volume is considerable and the current swift. It separates Miles City from the Fort Keogh Reservation along part of the eastern boundary of the latter.

The citizens of Miles City are desirous of having the river rectified and the banks protected along their water front, particularly at three points where the erosion caused by the flood current is said to have occasioned great loss of property. At one of these places there is danger that the river may cut entirely through its present bank and occupy the bed of an old slough, which is now dry except at high water. Such action would result in leaving the city on an island.

There is no present or prospective navigation on the Tongue River. No boats have run even on the Yellowstone for more than ten years. The latter river has been reported as not worthy of further improvement by the United States, although the sums appropriated for the work on it have not been entirely expended.

The desired rectification of the Tongue River, if undertaken, would be entirely for the preservation of property and would have no bearing whatever on the interests of navigation.

In my opinion the Tongue River is not worthy of improvement by the United States.

No survey is recommended.

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., September 29, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views and conclusions of the district engineer.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

APPENDIX A A.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF OBION, FORKED DEER, AND CANEY FORK RIVERS, TENNESSEE.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Obion River, Tennessee.
2. Forked Deer River, Tennessee.
3. Cumberland River, Tennessee and Kentucky.
4. Caney Fork River, Tennessee.

SURVEY.

5. Forked Deer River from Dyersburg, Tenn., to the Obion River and thence to the Mississippi.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., July 10, 1895.

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF OBION RIVER, TENNESSEE.

The Obion River flows wholly in the State of Tennessee, and is a tributary of the Mississippi River, which it enters near Hale Point, about 95 miles above Memphis.

This stream is formed by the junction of the north and south forks in the western part of Tennessee, and flows in a generally southwesterly direction for about 75 miles to the Mississippi. In its course the Obion receives the overflow from Reelfoot Lake and, about 3½ miles above its mouth, the waters of the Forked Deer River. At Obion the river is crossed by the bridge of the Newport News and Mississippi

Valley Railroad, which has no draw, and consequently forms an obstacle to navigation above that town.

An examination of this stream was made in 1880. (See Report of the Chief of Engineers, 1881, pp. 1486–1489.) An instrumental survey was made in 1891 from the railroad bridge at Obion to the mouth of the river, a distance of 68.8 miles, having a fall of 27 feet.

The course of the Obion is through a low, alluvial, and well-timbered country, subject to overflow, due in a great measure to backwater from the Mississippi. It has a width varying from 80 to 200 feet, and a depth generally of over 5 feet at low water, except at certain shoals, where in some places a depth of but 13 inches was found. The shoals are usually caused by obstructing driftwood, which holds sediment in place, and it is thought that the removal of the drift will aid in the removal of the shoals. The river is also greatly obstructed by snags and overhanging trees. The tortuous course of the river is a source of difficulty, some of the bends being very sharp, forming loops with narrow necks. At some of these points it might be well to make "cut-offs." There is but little current to contend against. As far back as 1843 surveys were made by the State of Tennessee and considerable work done by the State in clearing the river of surface obstructions, but the advantages gained were but of temporary duration.

The project for the improvement, based upon the survey of 1891 and the estimate of $50,000, consists of clearing the channel of snags, drift, and overhanging trees; constructing wing dams at the most obstructive shoals; straightening the very tortuous channel by cutting through several sharp bends and making the cut-offs sufficiently wide and deep by clearing, grubbing, and excavating; closing the old channel by means of pile and brush dams in order to secure at low water a navigable channel of not less than 3-foot depth between Obion and mouth of river.

The following appropriations have been made for this work by Congress:

Act of—	
July 13, 1892	$7,500
August 17, 1894	7,500

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1894, was $7,264.68, which has resulted in obtaining comparatively safe navigation for small steamboats. The channel has been greatly improved by the removal of surface obstructions, principally drift gorges, between Lane Ferry and Obion, Tenn., a distance of about 22 miles. In May, 1893, a small steamboat with two loaded barges passed up from Mr. C. A. Fleischhauer's lumber mills, near Lane Ferry, to Obion. This was the first boat to ascend the stream to Obion during fifty years.

Work of clearing the channel was begun September 25, 1894, and continued until February 28, 1895; was again resumed April 22 and closed May 28, 1895. A small steamboat was profitably employed to assist in snagging operations from January 11 to February 7, 1895.

The following work was done principally between Lane Ferry and Obion, Tenn.; the working force was employed between Lane Ferry and the mouth of the river during December and January, viz, 1,301 snags topped; 4,832 snags, stumps, and logs, and 682 cords of drift removed from channel; 339 cords of drift burned; 1,250 leaning trees cut down; 191 leaning trees topped; 597 logs and trees on banks cut up and removed; 675 logs pinned to banks to prevent being carried into the channel at high water.

The amount expended, including outstanding indebtedness, during the fiscal year was $4,170.65.

The commerce of this river is principally lumber, cut by sawmills now in operation on or near this stream.

Estimate of cost of improving Obion River, Tennessee	$50,000.00
Amount appropriated	15,000.00
Amount expended, including outstanding indebtedness	11,423.33

Money statement.

July 1, 1894, balance unexpended	$247.32
Amount appropriated by act of August 17, 1894	7,500.00
	7,747.32
June 30, 1895, amount expended during fiscal year	4,138.35
July 1, 1895, balance unexpended	3,608.97
July 1, 1895, outstanding liabilities	32.30
July 1, 1895, balance available	3,576.67
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Obion River, Tennessee, from July 1, 1894, to June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Spokes	20	Lumber	8,400
Logs	2,000	General merchandise	500

A A 2.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

[This work was in the charge of Capt. J. H. Willard, Corps of Engineers, until October 11, 1894.]

The Forked Deer River, about 29½ miles long, is wholly in the State of Tennessee, and is formed by the junction of the North and South Forks in Dyer County, about 8½ miles below Dyersburg; it flows in a southwesterly direction, entering the Obion River 3½ miles above its mouth, which stream becomes tributary to the Mississippi River at Hale Point, 95 miles above Memphis. Originally the mouth of Forked Deer River was near Ashport, about 18 miles below Hale Point, but about fifty-five years ago the State of Tennessee cut a canal, known as "Tiger-tail," to the bend of the Mississippi, which now includes the mouth of the Obion River, thus shortening the length of Forked Deer River about one-half. The original outlets below the canal, called "Lost" and "Old" channels, are now nearly filled up with snags and drift, but water flows through them at high-water stages in the Mississippi River.

The North Fork rises in Gibson County, joins the Middle Fork about 15 miles above Dyersburg, thence flows westerly past that town, forming a junction 8½ miles below with the South Fork.

The South Fork rises in McNairy County, and has a general southwesterly flow for about 250 miles. Jackson, 147 miles from its junction with the North Fork, is held to be the head of navigation.

Examinations of these streams have been made as follows:

(1) From Dyersburg on the North Fork to mouth of the main Forked Deer River, made in 1873 under act of March 3, 1873. (Report Chief of Engineers, 1874, Part I, pp. 372–380.)

(2) Of the South Fork, and of the North Fork, and of the main river, made in 1880 under act of June 14, 1880. (Report Chief of Engineers, 1881, pp. 1480–1497.)

(3) Of the North Fork, below Dyersburg, and of the main river (preliminary examination), made in 1886 under act of August 5, 1886. (Report Chief of Engineers, 1887, pp. 1494–1495.)

(4) From Dyersburg, Tenn., to its junction with the Obion River, and thence to the Mississippi River, made in October, 1894, under act of August 17, 1894. (House Ex. Doc. No. 156, Fifty-third Congress, third session.)

The obstructions were found to be snags, embedded logs, leaning trees, and large accumulations of drift; the channels of the upper sections of North and South Forks being very crooked and the bends short and numerous.

The original project provided for the removal of surface obstructions so as to give greater ease and safety to navigation of the South Fork between its junction with the North Fork and Brownsville Landing, a distance estimated to be about 73 miles. The project was modified in 1883 so as to extend operations up to Jackson, Tenn., a distance of about 75 miles. By acts of August 11, 1888, September 19, 1890, and July 13, 1892, appropriations were made for improving the North Fork, the South Fork, and the main river below their junction, under the general head of Forked Deer River; the project providing for the same class of channel work in the 8½ miles below Dyersburg, and in the main stream about 29½ miles.

The estimates of cost were $19,250 for South Fork, $4,500 for North Fork, and $7,000 for the Forked Deer River (main stream), based on plans for completing work in one season. (Report of Chief of Engineers, 1894, p. 1520.) In 1891 (Report of Chief of Engineers, p. 2013) the engineer officer then in charge reported that in his opinion the only work needed to be done could be completed with an additional appropriation of $3,000; thus to that extent completing the existing project. This amount was appropriated by act of July 13, 1892.

The appropriations have been as follows:

By acts of—	
August 2, 1882, for South fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888, for South Fork	2,500
Total for South Fork	12,500
August 11, 1888, for North Fork	4,500
August 11, 1888, for main river	2,500
September 19, 1890, for North Fork and main river	2,500
July 13, 1892, for Forked Deer River (completing improvement)	3,000
Total	25,000

The amount expended to June 30, 1894, in the removal of surface obstructions was $24,628.22—upon the South Fork, $12,500; upon the North Fork and main river, $12,128.22. These expenditures resulted in putting the North and South Forks in fairly good navigable condition,

and the removal of obstructions from the Forked Deer River (the main stream) enabled small boats to navigate it with greater ease and safety for a period of about eight months of the year.

Navigation of South Fork is carried on by flatboats, loaded with staves and lumber, and rafts of saw logs. Before the improvement commenced about one boat in three was lost on account of the obstructions in the channel; now boats make the trip in comparative safety and at less cost. The work in North Fork, below Dyersburg, has enabled boats to run at a stage of water 3 feet lower than formerly.

For a detailed report of operations from the beginning of the improvement by the United States, July 7, 1883, until June 30, 1894, see Report of Chief of Engineers, 1894, pages 1520–1522.

During July of the present fiscal year a small force was employed clearing the channel of Forked Deer River of surface obstructions between Skippers Cut off and the mouth of the river. The operations were confined to removing such obstructions as were most dangerous to navigation at medium and high stages of water and to making a boat channel at low stages. A small boat drawing not more than 2½ feet can now navigate the main stream at any time of the year.

The funds available being nearly exhausted, work in the channel was suspended July 7, 1894. Amount expended during the fiscal year, $268.03.

In the report of December 18, 1894, of the survey made in compliance with the river and harbor act of August 17, 1894, the opinion is expressed by the engineer officer in charge "that no satisfactory channel can be obtained on the Forked Deer River all the year by means of open-channel work, and that the cost of a slack-water system of navigation, with lifts not to exceed 6 or 7 feet, will reach $400,000 and be very expensive to maintain."

The expenditure of about $1,000 per year on the North and South forks and the main stream in simply keeping the channel clear of surface obstructions and giving safe navigation during high-water stages, thus maintaining the improved condition already secured, is recommended as warranted by the existing commerce.

The legislature of Tennessee at its last session passed an act "to declare the South Fork of the Forked Deer River navigable from Yellow Bluff levee and bridge to its mouth, and to repeal so much of an act passed March 23, 1883, as makes said river navigable above that point."

Yellow Bluff is about 2½ miles below the bridge of the Chesapeake, Ohio and Southwestern Railroad over the South Fork, and about 4 miles from its junction with the North Fork. Persistent efforts were made by parties interested in the lumber and rafting interests above Yellow Bluff in opposition to this legislation, but without success; its effect is apparently to simply repeal prior legislation declaring it to be navigable, and thus reduce the South Fork above Yellow Bluff to the class of streams upon which the legislature is silent as to its navigability; the stream being navigable in fact all the rights of commerce and navigation are held to be reserved.

Original estimates for improving the North and South Fork and main stream of the Forked Deer River	$30,750.00
Amount appropriated, including act of September 19, 1890	22,000.00
Estimate submitted to complete existing project—Report of Chief of Engineers, 1891, page 2014	3,000.00
Amount appropriated, act of July 13, 1892	3,000.00
Amount expended	24,896.25

Money statement.

July 1, 1894, balance unexpended	$371.78
June 30, 1895, amount expended during fiscal year	268.03
July 1, 1895, balance unexpended	103.75
July 1, 1895, outstanding liabilities	11.33
July 1, 1895, balance available	92.42

List of steamboats navigating Forked Deer River, Tennessee.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
James Laughlin*	71.5	15	4.5	28.76
Peoria Belle*	70.3	12.6	4.4	31.07
Mima				26.00
Mary Louisa	51	16	3	39.90
White Oak*				

* Towing barges.

COMMERCIAL STATISTICS.

Forked Deer River, Tennessee, from July 1, 1894, to June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Lumber	6,000	Stave bolts	5,000
Saw logs	131,000	General merchandise	500
Pipe staves	15,000		

NOTE.—It is reported to this office that the commerce above given was shipped or floated from points at a distance of from 55 miles to 75 miles above Yellow Bluff.

South Fork is crossed at Jackson by the Illinois Central, the Mobile and Ohio, and the Paducah, Tennessee and Alabama (Tennessee Midland) railroads, and at Bells Depot by the Louisville and Nashville Railroad; North Fork is crossed at Dyersburg by the Chesapeake, Ohio and Southwestern Railroad.

A A 3.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River rises in eastern Kentucky on the western slope of the Cumberland Mountains, flows in a tortuous course of about 688 miles through eastern Kentucky, middle Tennessee, and western Kentucky, and discharges into the Ohio River near Smithland, Ky. From Point Burnside, Ky., the head of steamboat navigation, to Smithland, Ky., is 205 miles on an air line, while by the way of the Cumberland River the distance is 518 miles, 203 miles being in the State of Kentucky, and 315 miles in the State of Tennessee.

From 1830 to 1840 the legislatures of Tennessee and Kentucky made several appropriations for the improvement of the navigation of the Cumberland River, but little benefit to the general condition of the river seems to have been accomplished. The Cumberland Navigation Company was incorporated by the State of Tennessee in 1846 for improving the "navigation of the Cumberland River below the town of Nash-

ville by means of a system of locks and dams," but nothing tangible was done to carry out the proposed improvement.

Congress appropriated $155,000 for improving the river by acts of—

July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

The amount was expended in carrying out the project authorized by act of Congress and based on the survey of Capt. Howard Stanbury.

From 1838 to 1871 no appropriations were made by Congress for improving the Cumberland River.

By act of July 11, 1870, Congress authorized an examination and survey of the Cumberland River. In reports of the Chief of Engineers, 1871, pages 468–485, and 1872, pages 463–472, may be found the reports of Maj. Godfrey Weitzel, Corps of Engineers, U. S. Army, giving description of the Cumberland River from the Great Falls of the Cumberland to the mouth of the river, at Smithland, Ky. This survey and estimates, which were increased in 1884 and 1888, furnished the basis of the project under which the work below Nashville has been carried on until the existing project was adopted in 1889. From Nashville to Smith Shoals the work was carried on under the project of 1871 until 1887. A survey of the river from the head of Smith Shoals to Nashville was made in 1882 and 1883. (See Report of Chief of Engineers, 1884, pp. 1663–1675.) On this survey is based the present project of improvement by locks and dams of the Cumberland River above Nashville. A survey of Smith Shoals made in 1874 (see Report of Chief of Engineers, 1875, pp. 795–800) is the basis of the project under which work was done at that obstruction from 1877–1883. A survey of the falls of the Cumberland River was made in 1878. (See Report of Chief of Engineers, 1879, pp. 1279–1282.) An examination above the falls was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1854–1859.)

Under provisions of act of August 11, 1888, a detailed instrumental survey was made of the "Lower Cumberland River from Nashville to its mouth to ascertain if necessary to establish locks and dams." (See Report of Chief of Engineers, 1890, pp. 2151–2161.)

The sixteen appropriations made by Congress from 1871 to 1894 amount to $1,696,000, and are itemized under the heads "below Nashville," and "above Nashville."

The obstructions are of a uniform character, consisting of rock ledges, sand and gravel bars, bowlders, snags, overhanging trees, and other surface obstructions. The Cumberland River supplies in many cases, both above and below Nashville, the only means of transit between the towns and villages lying along its course.

1. BELOW NASHVILLE (191 MILES).

The Cumberland River below Nashville is usually navigable for all steamboats plying on it for six months in each year; for boats not drawing over 3 feet, from six to eight months, and for boats drawing 16 inches or less, for a whole year.

Up to this time the channel work below Nashville has been carried on under the project of 1872, which, to quote from the original report, is—

To excavate the bars and rock ledges to get an additional depth of water, to contract the waterways in places to get the requisite depth, to remove snags and bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

In seasons of unusually low water the mouth of the river near Smithland, Ky., is seriously obstructed by the formation of sand bars.

Under the old project and estimates the following appropriations have been made for the section of the river below Nashville:

Act of—		Act of—	
March 3, 1871	$30,000	August 2, 1882	$15,000
June 10, 1872	20,000	July 5, 1884	7,500
March 3, 1873	25,000	August 5, 1886	12,500
March 3, 1875	25,000	August 11, 1888	10,000
June 18, 1878	45,000	September 19, 1890	40,000
March 3, 1879	40,000		
June 14, 1880	20,000	Total	305,000
March 3, 1881	15,000		

The Board of Engineer Officers (see Chief of Engineers' Report, 1888, pp. 1626–1632) recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600, so as to increase the depth of water at the shoals at the junction of the Cumberland River with the Ohio River. The river and harbor act approved September 19, 1890, provides that $30,000 of the appropriation for improving the Cumberland River below Nashville shall be expended in improving the mouth of the river, and the act of July 13, 1892, appropriated $40,000 for continuing the improvement, including the mouth of the river, and "that $10,000 of this sum, or so much thereof as may be necessary, shall be available for acquiring site and locating lock and dam near the mouth of Harpeth River, Tennessee, according to the survey and plan of Lieutenant-Colonel Barlow, Corps of Engineers, U. S. Army, submitted in December, 1889." This provision forms the initial appropriation for work under the plan above mentioned. The project now in force for improving this section of the river according to the plan submitted consists (1) of the extension of the lock and dam system of the Upper Cumberland to the lower river, by the construction of seven locks and dams extending from near the mouth of Harpeth River (Lock A) to Big Eddy Shoals (Lock G), the lock chambers to be each of 280 feet available length by 52 feet width, the lifts of the locks varying from 8½ to 11½ feet, aggregating about 70 feet; (2) of the improvement of the Kentucky Chute at mouth of river, as recommended by Board of Engineer Officers June 16, 1888 (Report of Chief of Engineers, 1888, p. 1628); (3) of the channel work necessary below Lock G, between Big Eddy Shoals and mouth of river, and (4) snagging and removal of surface obstructions below Nashville. Total estimate of cost of entire improvement under revised project, $1,964,500. (See Report of Chief of Engineers, 1890, pp. 2151–2161.)

The following appropriations have been made under the existing project:

Act of—	
July 13, 1892	$40,000
August 17, 1894	30,000

The total amount expended to June 30, 1894, including outstanding indebtedness, was $322,779.21, of which amount $303,639.14 was expended under the old project and $19,140.07 under the new project; $7,567.77 on account of lock and dam near mouth of Harpeth River, and $11,572.30 for general improvement and contingencies. This expenditure has resulted in lengthening the season of navigation by giving an increased depth at low water, combined with greater security in the passage of the worst obstructions, the work being carried on by hired labor. Improvements were specially obtained in the river at Harpeth

Shoals, Palmyra Bar, Elk Creek Shoals, Dover Shoals, Big Eddy Shoals, etc., by the clearing of the channel of surface obstructions; also in constructing a pile dike, under contract, at mouth of river and placing riprip protection on shore of Cumberland Island and the bank above foot of the island opposite the Kentucky mainland.

The Harpeth Shoals are the most formidable obstruction to the navigation of the Lower Cumberland, and to overcome this obstacle the existing project has in view that Lock and Dam A be begun and pressed to completion as soon as practicable. The sites for lock and abutment of dam (A) have been selected and approved. The site for Lock A (12 acres), about 2½ miles below the mouth of Harpeth River and about 41 miles below Nashville, has been acquired under condemnation proceedings and title vested in the United States.

During the present fiscal year the site for abutment of Dam A, 3.9 acres, has been acquired by the United States under proceedings in condemnation heretofore instituted. The construction of temporary buildings has been in progress and is nearly completed, the necessary machinery has been moved to the lock site and tramways, grading incline, hauling rock for engine beds and setting up machinery, together with other preparatory work necessary for active operations, building cofferdam, preparing foundation for walls of Lock A, have been carried on to the extent of the funds available for that purpose. This amount being very small, the work of lock construction beyond that above stated is impracticable until a new appropriation is made available for expenditure.

Channel work.—The work of clearing the channel between Nashville and mouth of river of surface obstructions, reducing points of rock reefs, and repairing dams, etc., was carried on from August 21 to December 11, 1894, special improvement being effected at Cumberland City Landing, Dover Landing, near Canton, Ky., and at Dycusburg, which had been very dangerous on account of outcropping rock points. Willows were planted as bank protection at upper, middle, and lower Gatlin Shoals, at Line Island, and at Race Track Dams and at other points. Riprap dam at Cam Owens, 36 miles below Nashville, was repaired.

The following was the work done:

Rock ledge reduced	cubic yards..	237
Solid rock removed	do....	76
Loose rock removed	do....	75
Earth removed	do....	25
Snags, logs, etc., removed	number..	2,206
Leaning trees cut down	do....	11,737
Brush cut	cubic feet..	163

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1895, was $12,560.18, divided as follows:

At mouth of river, act of September 19, 1890	$387.65
Lock and dam near mouth of Harpeth River, act of July 13, 1892	2,432.23
General improvement:	
Channel work, act of July 13, 1892	4,239.24
Lock and Dam A, act of August 17, 1894	5,501.06
Total	12,560.18
The estimate of cost of improving Cumberland River below Nashville, in accordance with revised and existing project of 1889	1,964,500.00
Amount appropriated under existing project	70,000.00
Amount expended under existing project, including outstanding indebtedness	30,796.40

Money statement.

July 1, 1894, balance unexpended	$22,736.99
Amount appropriated by act of August 17, 1894	30,000.00
	52,736.99
June 30, 1895, amount expended during fiscal year	7,969.30
July 1, 1895, balance unexpended	44,767.69
July 1, 1895, outstanding liabilities	4,590.88
July 1, 1895, balance available	40,176.81
Amount (estimated) required for completion of existing project	1,894,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

2. ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

The Cumberland River is navigable usually from Nashville to Point Burnside, Ky., 327 miles, for steamboats drawing not more than 3 feet from four to six months of each year, and for boats of greater draft from two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 116 miles), the river is navigable for steamboats of 2½ feet draft from six to eight months, and for those of greater draft four or five months. Steamboats of light draft can ascend to Burksville, 236 miles above Nashville, for from five to seven months, and larger boats four or five months.

The obstructions in the river above Nashville are of the same general character throughout; consisting of ledges, gravel and sand bars, bowlders, snags, overhanging trees, and rapid currents, and of milldams in the section of the river above the mouth of Jellico Creek.

About 50 miles above Burnside, Ky., are the Great Falls of the Cumberland, a vast barrier to navigation, the difference of level between crest and foot of main fall alone being about 54 feet. Smith Shoals, 10 miles above Burnside, Ky., having a fall of 55 feet in 8½ miles, form the most serious obstacle to navigation below the Great Falls.

The appropriations made by Congress for improving the Cumberland River above Nashville, under the original projects, were divided by years and geographical divisions as follows:

Geographical division.	Acts of—			
	Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.
1. Nashville to Kentucky line	$15,000	$20,000	$18,000	$15,000
2. Kentucky line to Smith Shoals	10,000	8,000	6,000	10,000
3. Smith Shoals	25,000	30,000	15,000	20,000
4. Smith Shoals to Falls of Cumberland	2,000	2,000	.....	.....
Total	52,000	60,000	39,000	45,000

Geographical division.	Acts of—			
	Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	Total.
1. Nashville to Kentucky line	$15,000	.....	.....	$83,000
2. Kentucky line to Smith Shoals	15,000	.....	.....	49,000
3. Smith Shoals	10,000	$15,000	.....	115,000
4. Smith Shoals to Falls of Cumberland	.....	.....	.....	4,000
5. Above mouth of Jellico, Kentucky	10,000	5,000	....	15,000
6. Nashville to Smith Shoals	.....	30,000	.....	30,000
7. Nashville to head of Smith Shoals	.....	.....	$50,000	50,000
Total	50,000	50,000	50,000	346,000

These appropriations, aggregating the sum of $346,000, have been expended in the several sections as designated, excepting the sum of $5,000 originally appropriated by act of August 2, 1882, for the section "above the mouth of Jellico, Kentucky," but which was made available by act of September 19, 1890, for expenditure and "to be applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn.," and which has been so expended.

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel over the worst shoals by excavation, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

The instrumental surveys of 1882 and 1883 (see Report of Chief of Engineers, 1884, p. 1663 et seq.) furnish the basis of the present project, modified in 1891, for the radical improvement of the Cumberland River above Nashville.

FROM NASHVILLE TO THE HEAD OF SMITH SHOALS.

The project originally provided for the construction of twenty-three locks and dams between Nashville and Burnside, Ky., and of seven locks and two dams at Smith Shoals, using the river itself as a canal, one dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922.

The act of July 5, 1884, appropriated $50,000 and provided that the "improvement shall be made according to the recommendation of Maj. W. R. King, engineer in charge, contained in the letter of Secretary of War, March 15, 1884, Senate Ex. Doc. No. 129, first session Forty-eighth Congress."

It is provided in said executive document that the dimensions of the 7 locks at Smith Shoals are to be "55 feet by 140 feet in the chamber," and the 23 locks between Nashville and Burnside, Ky., "should be about 60 feet wide and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose."

The act of August 5, 1886, specifically provided for this work of canalization "with a view to secure in the channel a depth of 4 feet, commencing with the lock at or near the lower island at Nashville." The Board of Engineer Officers constituted to examine and report upon the plan and estimate for this lock (No. 1) recommended a lock of the following dimensions: 280 feet long, 52 feet wide, from 10 to 12 feet lift, with 4 feet of water on lower and 5 feet on upper miter sill. This recommendation was approved by the Chief of Engineers and the Secretary of War. (See Report of Chief of Engineers, 1888, p. 1622 et seq.)

The plans first submitted provided for a lock (No. 1), fixed dam, and abutment of such dam, but upon further consideration by a Board of Engineers it was recommended conditionally and approved that a movable dam be constructed instead of a fixed dam. (See Report Chief of Engineers, 1890, p. 2143 et seq.) This Board in a subsequent report, dated November 26, 1890 (6793, 1890), for reasons therein given withdrew its former suggestion and recommended the construction of a fixed dam as originally proposed.

The style of dam being thus determined, new plans for Lock No. 1, with a lift of 9 feet and providing for a depth of water of 4 feet on the lower and 6½ feet on the upper miter sill and for a fixed dam and abut-

ment, were submitted to the Chief of Engineers and by him referred to the Board of Engineer Officers, who, in their report of April 20, 1891, recommended the plans for approval, and the report of the Board being approved by the Secretary of War April 25, 1891, the plan for Lock No. 1 submitted being "almost identical with the * * * plans for Lock No. 2." (See Report of Chief of Engineers, 1891, p. 2280 et seq.)

The Board of Engineers constituted to examine and report upon the plan and general design of Lock 2 recommended in their report November 25, 1890 (6727), a lock conforming to the dimensions prescribed for Lock 1, but recommending a depth of 6½ feet of water on the upper miter sill, and thus to provide for a minimum navigation of 6 feet instead of 4 feet, because "this can be done without extra cost," and is "necessary for the economical transportation of coal."

The plan for Lock 2, as approved, shows a uniform depth of 6½ feet of water on the sills, with a lift of 11 feet.

Locks of larger dimensions having been adopted as a modification of the project, it became necessary to revise the estimate submitted in 1882 and 1883, and such revision was made in the Annual Report of the Chief of Engineers, 1891, p. 2270, as follows:

Plans and estimates for Locks Nos. 1 and 2 have been prepared and contracts for portions of the work have been made, from which it is now estimated that each lock and dam will cost not less than $250,000. An estimate of the section from Nashville to Point Burnside, provided that twenty-three locks be found necessary, amounts to $5,750,000, and to continue the improvement to the head of Smith Shoals, with seven additional locks and dams of equal cost, would amount to $1,750,000 more, or a total of $7,500,000, an increase of the original estimate of $3,422,078, which modification is made and submitted in this report. By increasing the lift of the locks it may be found possible to decrease their number, and thus complete the improvement at a reduced cost.

The appropriations made for work under the present project from Nashville to the head of Smith Shoals, mouth of Rockcastle River, are as follows:

Act of—	
August 5, 1886	$75,000
August 11, 1888	200,000
September 19, 1890	250,000
July 13, 1892	250,000
August 17, 1894	200,000
Total	975,000

Congress provided that of the amounts appropriated by the acts of July 13, 1892, and August 17, 1894, for improving Cumberland River above Nashville $10,000 may be used "in the improvement of the river above the town of Burnside." It was recommended and approved that these sums, $5,000 from each of the above-named appropriations, be expended on the Smith Shoals system of lockage, consisting of seven locks and dams; that is, "be applied to continuing the work projected immediately above Burnside at Smith Shoals."

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1894, was $500,715.85, of which sum $11,015.67 was expended on the Smith Shoals section. This expenditure has been applied to the examinations of sites of Locks 1 to 7 and purchase of the sites for locks and abutments of Dams Nos. 1 to 5 and fencing same; completing examinations for sites of Locks 1 to 5, inclusive, of the Smith Shoals series; construction of masonry of lock and abutment of Dam No. 1 by contract; building lock keepers' house at Lock 1; building cofferdam and in payments in settlement of contract discontinued and terminated for building Lock 2 at the old site; clearing sites,

erecting temporary buildings, and fitting up steam travelers at Locks 2, 3, and 4; building cofferdams and landing piers, excavating lock pits and laying brickwork in foundation of river walls, and filling culverts of Locks 3 and 4; purchasing in open market stone for masonry of Lock 3; quarrying and cutting stone by hired labor and laying 352 cubic yards of river wall of Lock 4; purchase of dredge boat *Cumberland* and building new hull for same; changing U. S. steamer *Weitzel* into towboat suitable for heavy towage and refitting that vessel with powerful machinery, consisting of two new 12 by 4 inch engines, boiler, new wheel, etc.; constructing the light-draft steamboat *John Phœnix*, 65 feet long, 13 feet wide, and 2½ feet deep, for use in surveys for lock sites, etc.; building six large decked stone barges, each 110 feet by 22 feet by 5 feet, for moving stone and supplies to lock sites; clearing channel of surface obstructions; reducing rock ledges and gravel bars; repairing, extending, and building riprap dams at several points.

During the present fiscal year work has been prosecuted under the hired-labor system and the purchase of materials after due public notice, excepting that the stone for the masonry of Locks Nos. 2 and 5 is obtained under formal written contracts, which are still in force, viz: Petitdidier & Allen, Nashville, Tenn., October 13, 1894, for stone at Lock 2, total consideration, $57,864.50; James H. Connor, Lebanon, Tenn., January 19, 1895, for stone at Lock 5, total consideration, $57,724.

The total amount expended during the fiscal year, not including the expenditures on account of Smith Shoals, was $300,234.73, approximately divided as follows:

Lock No. 1	$118.50	Steamer Weitzel	$4,952.14
Lock No. 2	39,286.78	Steamer John Phœnix	824.20
Lock No. 3	119,554.01	Steamer Stephen H. Long	1,200.40
Lock No. 4	88,881.97	Steamer Susette	4,164.28
Lock No. 5	26,357.74	Office and contingent expenses	4,427.44
Lock No. 6	651.27	Channel work	5,675.92
Lock No. 7	948.86		
Lock No. 8	638.38	Total	300,234.73
Lock No. 21	1,659.76		
Lock No. 22	893.08		

Lock 1 (2.5 miles below Nashville).—Masonry of lock and abutment being completed, no further work has been done. Expenditures during the fiscal year were on account of watching and taking care of lock keepers' house and engineer property.

Lock 2 (9 miles above Nashville).—The cofferdam begun in April was completed in September. Lock-pit excavation was practically completed in December; about 7,737 cubic yards of sand and gravel were put in, and 475 cubic yards of riprap placed as protection to cofferdam; 5,409 cubic yards of earth placed behind crib work; 625 cubic yards of material used to strengthen embankment; 6 cubic yards of loose rock and 40 cubic yards of sand and gravel removed from lock site; 24,225 cubic yards of sand and gravel and 106 cubic yards of rock excavated from lock pit; 823.1 cubic yards of masonry of river wall laid; 3,040.97 cubic yards of stone for masonry delivered under contract. A large amount of miscellaneous work was done—stacking bricks, grading bank, building landing pier, concreting crevices, constructing tramway, trestles, sluices, etc., erecting derricks, and placing machinery in position for operating steam traveler, etc. Abutment site acquired by the United States October 26 and November 24, 1894.

Lock 3 (26 miles above Nashville).—Masonry of lock walls nearly completed; only a small quantity of the coping is yet to be laid. About 55

cubic yards solid rock and 2,193 cubic yards earth and loose stone excavated from lock pit; 1,415.5 cubic yards stone quarried for concrete, paving, and riprapping; paving slopes, 1,107 superficial yards; 30 cubic yards gravel spread on paving; 6,232 cubic yards filling placed behind lock walls; 7,561.6 cubic yards concrete laid in foundation of lock and filling culverts; 1,319 cubic yards sand dug; 792 cubic yards sand and gravel received on barges; masonry laid in walls and culverts, 473.9 cubic yards brick and 8,722.27 cubic yards stone. The stone for the masonry of this lock was purchased April 4, 1894, in open market after due public notice and competition, to be delivered as required, final delivery to be no later than July 1, 1895, this method being most economical and advantageous to the Government and the work. The aggregate quantity of stone purchased was 9,381.11 cubic yards, at a total cost of $68,698.03, delivered and paid for as follows:

Fiscal year.	Cubic yards.	Amount.
1894	1,015.02	$5,166.68
1895	8,366.09	63,531.35

Miscellaneous work: Grading slopes, repairing temporary buildings, removing cofferdam, pointing masonry of lock walls, taking down machinery, etc.

Lock 4 (*44.75 miles above Nashville*).—Masonry of lock walls completed in April; cofferdam removed; about 1,900 cubic yards earth excavated from lock pit; 2,442 cubic yards quarry stripped; 4,164 cubic yards stone quarried for masonry; 2,075.2 cubic yards stone cut; 9,691.9 cubic yards masonry, 245.6 cubic yards concrete, and 97,000 bricks laid in lock walls and filling culverts. Miscellaneous work done: Pointing lock walls, grading slope of bank, removing cofferdam, boating stone from quarry to lock site, clearing abutment site, paving bank and level behind lock walls, repairing dredge boat and pumps, and removing machinery, etc. Stonecutting, with other work for this lock, was done by hired labor.

Lock 5 (*72 miles above Nashville*).—Completed cofferdam and cribwork in August; about 10,663 cubic yards of material placed in cofferdam; 3,278 cubic yards of earth and rock removed from lock pit; 120 cubic yards dry wall built. Miscellaneous work: Clearing site, riprapping and paving bank and top of cofferdam, prospecting for quarries, building shed protection for machinery, concreting crevices in lock pit, building landing pier, setting up pumping machinery, etc; 670.49 cubic yards of stone for masonry of lock walls delivered under contract. The part of the lock site (1½ acres) not acquired during the last fiscal year was purchased and conveyed to the United States May 7, 1895.

Lock 6 (*89.5 miles above Nashville*).—The sites for the lock and abutment of dam have been approved; a part (6.29 acres) of the lock site was purchased of the owners and conveyed to the United States, February 2, 1895. The remainder of the lock site (1.51 acres) has been condemned and final decree of the U. S. district court for middle district of Tennessee rendered July 1, 1895, vested title to said 1.51 acres in the United States. The site for abutment of dam contains 5.05 acres; of this land 4.04 acres have been condemned and final decree rendered July 1, 1895, vested title in the United States upon payment for sites and approved costs in each case. The remainder of the abutment site (1.01 acres) has been purchased of the owner at an agreed and approved price, but conveyance of the land to the United States has not been

made pending an opinion of the Attorney-General of the United States as to title. No work has been done at this lock.

Locks 7, 8, 21, and 22 (107 miles, 125.25 miles, 296.25 miles, and 320.25 miles above Nashville, respectively).—The proposed sites of Locks 21 and 22 are located about 28¾ miles and 4¾ miles respectively below Burnside, Ky., and form the upper locks of the series above Nashville. The sites for the four locks and abutments of dams have been approved; efforts will be made to acquire the same by voluntary purchase at an approved reasonable price and conveyance from the several owners, if practicable.

The lands acquired and to be acquired by the United States for sites of locks and dams under the existing project, so far as determined, with distances from Nashville, acreage, and cost, are as follows:

No. 1. 2¼ miles below Nashville, 7.8 acres; cost, $1,360.
No. 2. Old site; 10¼ miles above Nashville, 12½ acres; cost, $750.43.
No. 2. New site; 9 miles above Nashville, 12.05 acres; cost, $1,606.25.
No. 3. 26 miles above Nashville, 15.2 acres; cost, $2,517.35.
No. 4. 44¼ miles above Nashville, 14.8 acres; cost, $2,401.56.
No. 5. 72 miles above Nashville, 18.5 acres; cost, $1,535.
No. 6. 98¼ miles above Nashville, 12.85 acres. Of the lock site 6.2 acres, costing $375, have been purchased and conveyed to the United States, 1.51 acres condemned and final decree rendered; action of the Department of Justice not yet received. Of the abutment site, 4.04 acres condemned and final decree rendered; action of Department of Justice not yet received. One and one-hundredth acres, voluntary purchase to be made from the owner; awaiting action of Department of Justice as to title.
No. 7. 107 miles above Nashville, 14.88 acres, not yet acquired.
No. 8. 125¼ miles above Nashville, 16.23 acres, not yet acquired.
No. 21. 296¼ miles above Nashville, 17.44 acres, not yet acquired.
No. 22. 320¼ miles above Nashville, 17.92 acres, not yet acquired.

U. S. S. Weitzel has been actively employed during the fiscal year in towing stone to the locks and moving the heavy supplies incident to the work of construction.

U. S. S. John Phœnix, being of light draft, has rendered good service while making the surveys for lock sites and in general service required by the work in progress and by assisting in the maintenance of the improved channel.

U. S. S. Stephen H. Long, pertaining to the works of improvement upon the Tennessee River and during the suspension of work upon that river and its upper tributaries, was transferred temporarily by authority for use upon the Cumberland River as a measure of economy and to prevent deterioration in value from nonusage. The steamboat was returned to the Tennessee River in January last.

U. S. S. Susette.—Authority was granted in November last to fit up a small steamboat for use upon the work of lock construction, building hull and using certain light machinery on hand suitable for the purpose. Construction of the hull of the vessel was begun in February and completed and launched in April; work of placing rudder and machinery in position, painting, etc., was in progress at the close of the fiscal year; the boat is nearly completed and ready for service.

Channel work.—Work in the channel was in progress at the beginning of the fiscal year near Carthage, Tenn., and was continued downstream during July and August to Nashville, Tenn., clearing away surface obstructions, etc. In August, work of repairing and extending dams and clearing channel at Fishing Creek Shoals and Forbush Shoals in the upper section of the river, a few miles below Burnside, Ky., was begun, and completed in October. The working party then moved downstream to Lower Hollemans Island, clearing the channel en route, where operations were suspended December 10 for the season. The

following is a summary of the channel work done during the fiscal year:

At Forbush Shoals (dam completed, 1,240 feet long, 14½ feet average width, 5 feet average depth):

Stone quarried	cubic yards	2,117
Gravel placed in dams	do	52
Riprap protection to dam	do	322
Snags removed		3,612
Leaning trees cut		18,842
Stone placed in dams	cubic yards	1,795
Brush cut and placed under dam	cords	143
Trees deadened		40

Smith Shoals.—From 1876 to 1882, each inclusive, the sum of $115,000 was appropriated for this section which has been expended in open channel work under the old project; operations being suspended in May, 1884. By act of September 19, 1890, Congress provided that of the general appropriation for improving Cumberland River above Nashville, $50,000 may be expended in commencing the improvement at Smith Shoals, and by acts of July 13, 1892, and August 17, 1894, provided that $5,000 of each of said general appropriations may be used in the improvement of the river above the town of Burnside. It was recommended and approved that these sums be applied in making the necessary surveys to determine the sites of the locks and dams required "above Burnside," or for the Smith Shoals system of lockage, consisting of seven locks and dams, as projected.

The maps on hand not containing data sufficiently in detail for the purpose of selecting the sites of any of the locks, a survey party was organized, and on July 25, 1892, an examination was begun of the river from Burnside, or the junction of the South Fork of the Cumberland, to the mouth of Rockcastle River, about 30 miles, and having a fall of 77 feet in that distance. The amount expended on this section to June 30, 1894, was $11,015.67, which was applied to the survey of the river, having in view the selection of sites for the locks and dams of the Smith Shoals series and in payment of current authorized expenditures. An extensive system of test borings and soundings was necessary in order to determine the location of the sites most suitable. Sites for Locks and Dams Nos. 1 to 5, inclusive, were selected and maps completed showing the location of the same.

During the present fiscal year a line of levels from Burnside to Mill Springs, 24 miles, was run to establish pool level below Lock 1; made examinations and borings, having in view the selection of sites for Lock and Dam No. 6, these examinations were completed in September and lock and dam located. Survey made of mouth of "Suck" and line of levels run into the cave at Cave Creek. Property lines at the several sites were run, marked, and referenced, and lines shown to owners. Amount expended, $4,727.91.

Seven locks and dams providing for 6-foot navigation form the basis of the present project, but it is now ascertained that the seventh lock will not be necessary, owing to an increase of lift in the other locks which is rendered advisable by reason of the small-river discharge at low water not permitting of any material loss during the season of navigation; also, simplicity of operation and maintenance at the rather inaccessible locations necessarily selected for the sites. A report in detail, with accompanying maps, of the survey of the Smith Shoals section, from Burnside, Ky., to the mouth of Rock Castle River, in connection with the projected canalization of the Cumberland River above Nashville, Tenn., was prepared during the fiscal year and transmitted

July 1, 1895, to the Chief of Engineers, through the division engineer of the southwest division. Maps of the proposed sites for locks and dams Nos. 1 and 2, Smith Shoals system, were also completed and forwarded July 2, 1895, to the Chief of Engineers, through the division engineer, recommended for approval.

Amount allotted at Smith Shoals, act of September 19, 1890	$50,000.00
Amount allotted "above Burnside," act of July 13, 1892	5,000.00
Amount allotted "above Burnside," act of August 17, 1894	5,000.00
Total allotted	60,000.00
Amounted expended	15,743.58
Balance available, July 1, 1895	44,256.42

The field and office work pertaining to the surveys of the sites for locks and dams, forming part of the project for canalization of the Cumberland River from the mouth of Harpeth River on the Cumberland River below Nashville to the head of Smith Shoals, mouth of Rock Castle River, including the work of lock construction in progress, has been and now is under the efficient immediate management of Mr. J. S. Walker, assistant engineer.

The amount herein below estimated for continuing the work, $1,500,000, can be profitably expended at locks and dams Nos. 1 to 5, inclusive; finishing Locks 2 and 5; building the dams and abutments; constructing lock gates and maneuvering appliances, having in view as far as practicable the completion of the five locks and dams, and opening the same to navigation, as projected (1943 of 1893); in laying masonry of Locks 6, 7, 8, 21, and 22, the sites for said locks having been determined and authority granted to acquire the same, the site of Lock 6 being already in part acquired. Maps of the sites for Locks 1 and 2 of the Smith Shoals series have been submitted; if approved, it is proposed that work be begun at those sites when acquired. About $5,000 of the amount estimated for should be held available for expenditure in channel work between Burnside and Nashville so as to maintain the channel in good navigable condition during the progress of lock construction.

Estimate for improving Cumberland River by locks and dams from Nashville to head of Smith Shoals, as modified in 1891	$7,500,000.00
Amount appropriated	975,000.00
Amount expended, including outstanding indebtedness and covered by uncompleted contracts	872,485.31

Money statement.

July 1, 1894, balance unexpended		$325,051.17
Amount appropriated by act of August 17, 1894		200,000.00
		525,051.17
June 30, 1895, amount expended during fiscal year		304,962.64
July 1, 1895, balance unexpended		220,088.53
July 1, 1895, outstanding liabilities	$7,020.60	
July 1, 1895, amount covered by uncompleted contracts	110,553.24	
		117,573.84
July 1, 1895, balance available		102,514.69

Amount (estimated) required for completion of existing project	6,525,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	1,500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for furnishing stone for Lock No. 2, delivered on barges in Cumberland River, opened September 25, 1894, by Capt. John Biddle, Corps of Engineers.

No.	Name and address of bidder.	Sills, 93 cubic yards.		Hollow quoins, 98 cubic yards.		Special stones, 200 cubic yards.		Coping, 350 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	Patterson & Shipman, Washington, D. C.	$15.00	$1,395.00	$25.00	$2,450.00	$14.00	$2,800.00	$14.00	$4,900.00
2	Petitdidier & Allen, Nashville, Tenn.	15.50	1,441.50	21.00	2,058.00	13.50	2,700.00	13.50	4,725.00
3	H. P. McDonald, Louisville, Ky.	16.00	1,488.00	16.00	1,568.00	13.90	2,780.00	13.50	4,725.00
4	P. H. McCormack, Columbus, Ind.	20.00	1,860.00	25.00	2,450.00	16.50	3,300.00	20.00	7,000.00
5	Salem-Bedford Stone Co., Louisville, Ky.	14.40	1,339.20	15.40	1,509.20	15.40	3,080.00	13.90	4,865.00
6	Foster & Creighton, Nashville, Tenn.	16.80	1,562.40	19.85	1,945.30	14.35	2,870.00	16.00	5,600.00

No.	Name and address of bidder.	Pointed face, 2,000 cubic yards.		Square-faced rubble, 1,820 cubic yards.		Backing, 7,000 cubic yards.		Grand total cost.
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	
1	Patterson & Shipman, Washington, D. C.	$9.50	$19,000.00	$8.00	$10,560.00	$7.50	$52,500.00	$93,605.00
2	Petitdidier & Allen, Nashville, Tenn.	10.00	20,000.00	4.50	5,940.00	3.00	21,000.00	57,864.50
3	H. P. McDonald, Louisville, Ky.	9.95	19,900.00	6.60	8,712.00	4.00	28,000.00	67,173.60
4	P. H. McCormack, Columbus, Ind.	10.50	21,000.00	7.00	9,240.00	5.00	35,000.00	79,850.00
5	Salem-Bedford Stone Co., Louisville, Ky.	12.25	24,500.00	11.54	15,232.80	9.59	67,130.00	177,656.20
6	Foster & Creighton, Nashville, Tenn.	12.40	24,800.00	5.70	7,524.00	4.70	32,900.00	77,201.70

Abstract of proposals for furnishing stone for Lock No. 5, delivered on barges in Cumberland River, opened December 5, 1894, by Capt. John Biddle, Corps of Engineers.

No.	Name and address of bidder.	Sills, 93 cubic yards.		Hollow quoins, 98 cubic yards.		Special stones, 200 cubic yards.		Coping, 350 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	James E. Sloan & Co., Nashville, Tenn.	$35.00	$3,255.00	$27.50	$2,695.00	$15.00	$3,000.00	$20.00	$7,000.00
2	J. A. Doyle & Co., Knoxville, Tenn.	15.30	1,422.90	21.50	2,107.00	15.00	3,000.00	14.50	5,075.00
3	J. S. Hutton & Son, Birmingham, Ala.	22.00	2,046.00	25.00	2,450.00	25.00	5,000.00	20.00	7,000.00
4	Eichel & Arnold, Evansville, Ind.	15.54	1,445.22	17.16	1,681.68	16.89	3,378.00	13.65	4,777.50
5	John Short, St. Charles, Mo.	15.20	1,413.60	20.80	2,038.40	14.20	2,840.00	13.75	4,812.50
6	J. H. Connor, Lebanon, Tenn.	12.00	1,116.00	16.00	1,568.00	12.00	2,400.00	12.00	4,200.00
7	Foster & Creighton, Nashville, Tenn.	15.70	1,460.10	16.70	1,336.60	16.50	3,300.00	14.80	5,180.00
8	Robert McCarrel & C. F. King, Charleston, S. C.	16.50	1,534.50	23.10	2,263.80	14.85	2,970.00	14.85	5,197.50

Abstract of proposals for furnishing stone for Lock No. 5, etc.—Continued.

No.	Name and address of bidder.	Pointed face, 2,000 cubic yards.		Square-faced rubble, 1,320 cubic yards.		Backing, 7,000 cubic yards.		Grand total cost.
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	
1	James E. Sloan & Co., Nashville, Tenn	$8.00	$16,000.00	$5.00	$6,600.00	$4.00	$28,000.00	$66,550.00
2	J. A. Doyle & Co, Knoxville, Tenn	11.00	22,000.00	4.90	6,468.00	3.50	24,500.00	64.572.90
3	J. S. Hutton & Son., Birmingham, Ala	11.00	22,000.00	8.00	10,560.00	5.75	40,250.00	89,306.00
4	Eichel & Arnold, Evansville, Ind	12.84	25,680.00	12.30	16,236.00	11.40	79,800.00	132,998.40
5	John Short, St. Charles, Mo	10.15	20,306.00	4.00	5,280.00	2.20	15,400.00	52,984.50
6	J. H. Connor, Lebanon, Tenn	9.00	18,000.00	4.50	5,940.00	3.50	24,500.00	57,724.00
7	Foster & Creighton, Nashville, Tenn	13.55	27,100.00	5.60	7,392.00	4.00	28,000.00	74,068.70
8	Robert McCarrel & C. F. King, Charleston, S. C	11.00	22,000.00	4.95	6,534.00	3.30	23,100.00	63,599.80

List of steamboats (stern-wheel) plying on Cumberland River, Tennessee and Kentucky.

Name.	Length.	Breadth.	Depth.	Tonnage, net.
	Feet.	*Feet.*	*Feet.*	
Ashland City	120	20	3.9	94.55
Alex Perry	149.9	28.5	3.5	172.76
John Orm, No. 3	95	17	3.5	95.33
John W. Hart	168	29	3	215.97
O. E. Stockell	103.6	20.3	3	69
W. K. Phillips	165	30	4	195.06
Jas. N. White	147	27	3	77.19
P. D. Staggs	161	28.6	4.4	261.28
A. L. Goldberg	129	20	3	58.20
W. T. Harwell	72.9	15.9	3.8	24.48
City of Savannah	190	34	5	335.55

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from July 1, 1894, to June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Logs and lumber	203,510	Hay	917
Grain	8,410	Salt	587
Flour	7,189	Cattle	442
Wood	5,250	Coal	415
Iron	3,151	Hogs	297
Tobacco	3,125	Horses and mules	266
Staves	2,390	Cotton	52
Sand	1,500	Shingles	41
Bricks	1,072	General merchandise	8,929

Cumberland River above Nashville, Tenn., from July 1, 1894, to June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Sand	13,776	Flour	1,225
Logs	12,000	Hogs	1,000
Lumber	10,250	Hay	269
Staves	5,211	Cross-ties	260
Grain	4,405	Horses and mules	251
Tobacco	3,585	Bricks	161
Salt	3,000	Cotton	150
Cattle	1,788	Wood	130
Coal	2,570	Shingles	53
Iron	1,275	General merchandise	18,235

Cumberland River above Nashville, Tenn., above Burnside, Smith Shoals, from July 1, 1894, to June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Logs	24,000	Cedar posts	7,000
Cross-ties	22,313	Staves	200
Coal	8,000		

A A 4.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

The Caney Fork River rises in the plateau of the Cumberland Mountains, about 18 miles east of Sparta, Tenn., and discharges into the Cumberland River at Carthage, about 116 miles above Nashville and 209 miles below Burnside, Ky. This stream is about 200 miles long and has its course and watershed wholly in Tennessee and is navigable during the boating season to Frank Ferry, about 92 miles from its mouth. Under the provisions of act of Congress approved June 18, 1878, an examination was made in February, 1879, from the mouth of the river to Sligo Ford, 72 miles. (See Report of Chief of Engineers, 1879, pp. 1275–1277.) In compliance with provisions of act of Congress approved July 5, 1884, the examination of 1879 was extended in 1886 from Sligo Ford to Frank Ferry, a distance of 20 miles. (See Report of Chief of Engineers, 1887, pp. 1768–1771.) During these examinations the channel was found to be obstructed by rock reefs, sand and gravel bars, snags, and overhanging trees.

The fall from Frank Ferry to mouth of river, 92 miles, was estimated to be about 132½ feet, 62½ feet of which is in the upper 20 miles.

The present project, based on the data obtained during these examinations, is to improve the 92 miles of river from Frank Ferry to its mouth by removing the surface obstructions brought down by the annual floods and building necessary riprap dams and training walls so as to obtain sufficient water for safe navigation for steamboats drawing not more than 3 feet during the usual boating season of about five months, from February to July.

The following appropriations have been made for this work by acts of Congress, viz:

Act of—	
June 14, 1880	$6,000
March 3, 1881	4,000
August 2, 1882	4,000
July 5, 1884	3,000
August 5, 1886	3,000
August 11, 1888	2,500
September 19, 1890	2,500
Total	25,000

No appropriations were made for this river by the acts of July 13, 1892, and August 17, 1894.

The amount expended to June 30, 1894, including outstanding indebtedness, was $25,000, the total amount appropriated, which was used in removing snags and drift brought down by the annual floods, cutting overhanging trees, reducing sand and gravel bars, repairing and building wing dams, etc., and has resulted in securing an improved channel from Frank Ferry to the mouth of river. The work done in clearing

the channel will be of great advantage to rafts and flatboats coming down on the so-called "rain tides." No channel work has been carried on since August, 1891, the available funds being exhausted. The engineer property pertaining to this work is placed with other property on the Cumberland River as a measure of economy and safety.

No expenditures were made during the present fiscal year.

The improvements made have not caused any increase in the commerce of this stream; that is, by means of steamboats. Only one boat made one trip during the last two fiscal years, bringing out a cargo of corn from points in the vicinity of Trousdale Ferry.

As stated in the last annual report, the commerce, however, has consisted as heretofore of logs and lumber in rafts, but the merchants state that rafts reach them made of logs from the Cumberland River and its several tributaries, and that they have no means whereby to report separately the number of logs or rafts received from the Caney Fork River.

Therefore it can not be satisfactorily nor accurately ascertained whether or not the tonnage of rafts is increasing.

In view of the limited commerce, present and prospective, it is not deemed advisable to recommend that any further expenditures be made upon the Caney Fork River in order to obtain a navigable channel at a stage of 3 feet above low water, as projected.

Estimate for improving Caney Fork River from its mouth to Frank Ferry	$45,228
Amount appropriated	25,000
Amount expended, including outstanding liabilities	25,000

Money statement.

July 1, 1894, balance unexpended	$20.00
July 1, 1895, balance unexpended	20.00
July 1, 1895, outstanding liabilities	20.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,228.00

A A 5.

SURVEY OF FORKED DEER RIVER FROM DYERSBURG, TENNESSEE, TO ITS JUNCTION WITH THE OBION RIVER AND THENCE TO THE MISSISSIPPI RIVER, SO AS TO MAKE SAID STREAM NAVIGABLE ALL THE YEAR.

[Printed in House Ex. Doc. No. 156, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 28, 1894.

SIR: I have the honor to submit the accompanying copy of report of December 18, 1894, by Capt. John Biddle, Corps of Engineers, of the results of a survey of "Forked Deer River from Dyersburg, Tenn., to its junction with the Obion River and thence to the Mississippi River, so as to make said stream navigable all the year," made to comply with requirements of the river and harbor act of August 17, 1894.

Captain Biddle is of opinion that no satisfactory channel can be obtained on the Forked Deer River all the year by means of open-channel works, and that the cost of a slack-water system of naviga-

tion, with lifts not to exceed 6 or 7 feet, will reach $400,000 and be very expensive to maintain.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., December 18, 1894.

GENERAL: In compliance with instructions of September 14, 1894, from your office, I have the honor to submit the following report of a survey of the Forked Deer River, Tennessee:

The river and harbor act of August 17, 1894, directed a survey to be made of the Forked Deer River from Dyersburg, Tenn., to its junction with the Obion River and thence to the Mississippi River, so as to make said stream navigable all the year.

Two letters from Capt. J. H. Willard, Corps of Engineers, of August 29 and of September 10, 1894, were inclosed with the instructions, and are herewith returned. Attention is respectfully invited to these letters as giving in detail the work already done.

Seven hundred dollars was allotted for this survey. This sum, of course, does not allow of much detail or elaboration. While the data submitted are presumably correct, additional surveys would be necessary before making any well-defined plan for radical improvement or definitely locating any works.

Up to this time the general project of improving the Forked Deer River has been to clear away the greater obstructions, consisting usually of timber in some shape, so as to make it navigable for small craft at a 3-foot or higher stage.

Dyersburg lies on the North or Middle Fork of Forked Deer River about 8.5 miles above its junction with the South Fork. The amounts appropriated for the North Fork and the main river have been $12,500 (see Report of Chief of Engineers for 1894), and practically all this amount has been expended. Appropriations to the extent of $15,000 have been made for improving the Obion River, which sum has in part been expended in improving this river in its upper reaches, and not as yet below the mouth of the Forked Deer River.

From this latter stream a number of snags, logs, overhanging trees, etc., have been removed and navigation improved. Such work is, however, but temporary, as the river, left to itself, rapidly fills again with surface obstructions. The present survey was made under the immediate charge of Mr. Benj. B. Smith, whose report is appended. The Forked Deer River, from Dyersburg to the South Fork, is 8.5 miles long; thence 21 miles to the Obion River, and thence 3.5 miles to the Mississippi River; in all, 33 miles. The fall at low water is 26.5 feet, at high water 6.5 feet. These slopes are, however, much affected by the relative stages of the Mississippi. A running out of the Forked Deer, brought about by a sudden rise while the Mississippi is low, causes greater slopes. The high water at Dyersburg is 22.5 feet above low water, and at the mouth of the Obion 42.5 feet. For the description of those portions of the rivers pertaining to this survey, they may be

divided in three sections: From Dyersburg to Key Corner, 20 miles; thence to the Obion, 9.5 miles; thence to the Mississippi, 3.5 miles.

The first section, from Dyersburg to Key Corner, 20 miles, has a fall of 6.5 feet. The width averages 65 feet above the South Fork, and from 150 feet to 200 feet below that point, with occasional narrower places. The banks are 8 feet to 10 feet above low water, and usually in fair shape. The depth is, as a rule, good, there being only a few shallow places, and, the fall not being great, these could, I think, be readily improved. This part has been fairly cleared of snags and other like obstructions.

The second section, from Key Corner to the Obion, 9.5 miles in length, has a fall of nearly 16 feet at low water, and on one stretch a fall of about 5 feet in 1.5 miles. The river widens to about 200 feet. The depth is slight—often less than 1.5 feet. The banks vary from 10 feet to 30 feet in height, and are of soft material. This stretch is full of snags and logs. The bottom is formed of shifting sand bars. It is stated by the pilots and inhabitants that the Mississippi, when it overflows, carries its sand and silt and deposits them in this river up to this point—Key Corner—and such action seems probable. The whole regimen of this section is very unstable, and all works of improvement undertaken are liable to prove of but temporary benefit. The erosion of the banks is very great, especially when the Forked Deer rises rapidly while the Mississippi is low.

The old channels of the Forked Deer, through which it formerly emptied directly into the Mississippi, connect with this section. They are mostly filled up, but at higher stages water flows through them.

The third section comprises the Obion River, from the mouth of the Forked Deer to the Mississippi, 3.5 miles with a fall of 4 feet. The river is narrow, not much over 100 feet. It is usually deep. The banks are about 30 feet high, alluvial, and cutting. There is a bar at the mouth of the Forked Deer, and a very extensive one at the mouth of the Obion, formed by the Mississippi. The Mississippi River is presumed to have once followed this channel, but it must have been many years ago, as the bed of the Obion is very narrow and the banks covered with large timber.

The changes in the Forked Deer since 1874, as shown by comparison with other maps, are several "cut-offs," cutting away of banks, formation and shifting of bars, etc. The bar at the mouth of the Obion has been formed by the Mississippi mostly within a few years, and illustrates the difficulty of making any accurate estimate of the cost of improvement. As the Mississippi rises it flows through its old channel, and then up the Forked Deer and down the former mouths of this stream, and at high water the greater part of the country is flooded.

To make the river navigable all the year the lowest stages of the Forked Deer, Obion, and Mississippi must be considered, as it is now navigable for small craft at higher stages, though the navigation may at any time be hindered or interrupted by falling trees, roots, etc. The autumn of 1894 has been characterized by continuous and exceptionally low water, so that it may be taken as at the lowest stage throughout.

A least clear depth of 3 feet and a width of 100 feet are adopted as the smallest channel that would give satisfactory navigation. A depth of 5 feet would be better, but much more difficult to obtain. A less width than 100 feet would permit of navigation, in fact above the South Fork the river averages much less, yet I am of the opinion that, due to the numerous curves, to the chance falling in of trees, to the sudden formation and shifting of bars, any width less than 100 feet would

not be worthy of extensive improvement so as to give satisfactory navigation.

The two general methods of improvement of rivers are by open channel work, by means of check dams, channel excavation, etc., and by slack water—that is, locks and dams. The first method is more satisfactory where it can be applied. It needs, however, a considerable flow of water.

Applying this method to the river in question, I am of the opinion that on the first section a depth of 3 feet could be obtained by dredging and perhaps a narrowing of the channel.

On the second section the question is very difficult. The fall is very steep, the current rapid, and the supply of water limited. Any clearing of the channel will diminish the resistance to flow of the water, increase its velocity, and thence decrease its depth. If the width is diminished by wing dams the banks must be protected, so that the bottom will scour, and the surface of the water will be lowered; the pools above will thus be diminished and new obstructions show themselves.

There is no way that the general slope on this stretch can be sensibly modified. The formulas for the amount of water necessary to fill a certain channel with a defined slope are not very well determined. Taking the tables as deduced by Mr. P. J. Flynn in his work on Irrigation Canals, and based on Kutter's formulas, it would appear that, taking the total stretch of 9½ miles, with the fall of the Forked Deer in this section, there would be only two-thirds enough water to fill the required channel. If the stretch of 1½ miles, where the fall is 5 feet, is considered there would be only one-third enough water.

When it is remembered that the fall is concentrated at points and not evenly distributed, making the actual fall much greater than the average; that the softness of the bottom and banks makes all works unstable; that the clearing will cause increased current and still more lower the pools; that the lowering of the pools will introduce new obstructions, etc., I believe that it is certain that the required channel can not be permanently obtained by any system of open-channel work.

The experience on rivers in this district, such as the Lower Cumberland, where, with a much greater discharge, locks and dams are resorted to; the Obion, where, with about four-fifths discharge and only half the slope, navigation only at medium stages is attempted; and others corroborate me in this opinion. This is also the opinion of Capt. J. H. Willard, Corps of Engineers, as expressed in his letter of September 10, 1894.

There then remains the system by slack water, or locks and dams. For this I adopt a least depth of 5 feet over the miter sill, as it is much preferable and not much more difficult to obtain.

In the report of Mr. J. Jay Williams, of the State commission for improvement of waterways, quoted by Capt. J. H. Willard, a lock of 125 by 25 feet is adopted for the proposed canal joining the Tennessee and Mississippi rivers. While Dyersburg is not directly on the proposed line of the canal, which passes through the South Fork, yet it would presumably be benefited by the same, and that size of lock is therefore estimated on. This lock would pass any craft that could well navigate this river. The exact location of the locks can not be determined from the data on hand. On account of the lowness of the banks, the least practicable lift would be desirable. It might be well to state here that any system of locks and dams would probably seriously

affect the drainage of this section of country, and to secure this drainage seems to be one of the aims of the inhabitants in having the river improved.

A lift greater than 6 or 7 feet should not be exceeded. There would then be four locks, or, at the very least, three locks. A guard lock would probably be necessary. I therefore estimate for four locks.

On account of the absence of stone, concrete would, I think, be the best material for the lock. It would be built on a pile foundation. The dam might be made of piles and stone. On account of the softness of the bottom banks, a considerable apron both below the dam and below the lock will be obligatory, and the banks must be well protected all around the lock and dam. Riprap forms the best protection for this purpose, but will be very expensive, on account of the distance from which it must be brought.

A general estimate of the cost of a lock and dam may be itemized as follows:

Cofferdam of piles	$2,800
Excavation and back filling	3,000
Foundation, piles, grillage, concrete, and flooring	12,000
Masonry	20,000
Gates, valves, etc	2,500
Abutments	6,000
Dam	7,500
Land	1,200
Fencing, houses, tools, etc	3,000
Protecting banks, paving, etc	5,000
	63,000
Office and engineering contingencies	12,000
Total	75,000

Multiplying this by four gives $300,000 as the cost of the locks and dams.

Besides the locks, the river would have to be thoroughly cleared. In view of the cost of work on the Obion, where 22 miles of river will have been fairly well cleared for about $15,000, I estimate the snagging at $25,000, as there are many cypress knees on the bottoms to be removed.

A dredge boat would be necessary to remove the bar at the mouth of the Obion and at other places. An efficient dredge boat would cost about $20,000. The amount of material to be removed would depend on the location of the locks; on making the necessary "cut-offs;" on the action of the Mississippi with reference to the bar at the mouth of the Obion; on the deposit from overflow, and other causes. It might prove necessary to keep the Mississippi out of its old channels by levees. All this work is so indefinite from the data on hand that no reliable estimate can be made. The bank, besides, would have to be protected in many places. A steamboat and barges would be necessary to carry on the work.

In all, I believe that there is no doubt that the total cost will be $400,000. I therefore respectfully express the opinion that no satisfactory channel can be obtained on the Forked Deer River all the year by means of open-channel works, and that the cost of a slack-water system of navigation, with lifts not to exceed 6 or 7 feet, will reach $400,000 and be very expensive to maintain.

The estimate is tabulated as follows:

Four locks and dams, at $75,000 each	$300,000
Snagging	25,000
Steamboat and barges	15,000
Dredge boat	20,000
Making cut-offs, dredging bars, bank protection	40,000
Total estimate	400,000

A map* of the survey to accompany this report is in preparation, and will be forwarded as soon as practicable.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, December 24, 1894.

Respectfully forwarded to the Chief of Engineers.

The Forked Deer and Obion rivers are so insignificant that I concur with Captain Biddle in the opinion that they can not be made "navigable all the year," as specified in the river and harbor act of August 17, 1894, except by locks and dams. Even with locks and dams the navigability of the lower part of the Obion and its entrance into the Mississippi will depend on the amount of mud and sand which the Mississippi in its floods annually deposits here and which would have to be annually removed. The cost of this maintenance would largely increase the estimated cost of $400,000.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. BENJ. B. SMITH, SURVEYOR.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn.

CAPTAIN: I have the honor to submit the following report on survey of Forked Deer River, Tennessee, from Chesapeake, Ohio and Southwestern Railroad Bridge at Dyersburg, Tenn., to Tiger Tail, and of Obion River from Tiger Tail to the Mississippi River. The Forked Deer River, Tennessee, is formed by the junction of three forks, known respectively as North, Middle, and South Forks. The North Fork rises in Gibson County and flows in a southwesterly direction, entering the Middle Fork about 15 miles above Dyersburg, Tenn. The Middle Fork takes its rise in Madison County, flows in a general westerly direction past Dyersburg, Tenn., and forms a junction with South Fork 8¼ miles below Dyersburg. The South Fork heads in Chester and Henderson counties, flows past Jackson and Bells Depot, forming with the Middle Fork the main Forked Deer River, which flows in a southwesterly direction a distance of 20 miles, entering the Obion River at Tiger Tail. Originally the Forked Deer River flowed through two channels, now known as Lost and Old channels, and emptied into the Mississippi River at Ashport, 19 miles below its present outlet. In 1845 the State of Tennessee cut a canal from the Forked Deer River to the then Mississippi River, a distance of about three-quarters of a mile; this canal is now known as Tiger Tail. Since that time the Old and Lost channels of the Forked Deer River have become closed by drift and the Mississippi River has moved 4 miles to the westward, leaving the outlet of the

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*Not sent.

Forked Deer River through the lower reaches of the Obion River. At different times between the years 1854 and 1874, the State of Tennessee made appropriations for the improvement of the Forked Deer River, these sums aggregating $43,000. Old citizens of Dyersburg state that during this period the river from the Mississippi to Dyersburg, on Middle Fork, and for some distance up South Fork, was navigable for small boats during the greater part of the year, and that most of the produce of the country—lumber, corn, cotton, tobacco, and hogs—went to the markets through this channel. Under the river and harbor act of March 3, 1873, an examination of the Forked Deer River was made from Dyersburg, on Middle Fork, to the mouth of the main river. Operations for improvement have been confined to snagging, the removal of drift and overhanging trees, and other work pertaining to keeping the channel clear for navigation. No improvement of the channel itself has been attempted.

The present survey consisted of an examination with transit and stadia and a line of levels to obtain the fall of the river. The surveying party consisted of myself, Mr. A. E. Roscoe, and five men. We commenced the survey at the Chesapeake, Ohio and Southwestern Railroad Bridge, 1 mile above Dyersburg, on October 10, 1894, the survey being made without interruption, and at an extreme low-water stage, and terminating at the Mississippi River on November 2, 1894. The methods used were as follows: A continuous transit and stadia line was run throughout, average readings on the stadia being about 600 feet, and never exceeding 1,200 feet; all necessary intermediate points were rodded in, and a continuous sketch of the river carried throughout. This sketch was made as detailed as possible, comprising all houses, roads, fences, and cultivated lands in sight from the river; the shapes of bends and bars; all drift piles and snags; careful notes being made of caving banks and all points necessary to a thorough examination. Cross sections of the river channel and banks were taken wherever natural characteristics, such as unusually low or caving banks, heavy sand bars, or shallow shoals seemed to demand. Water-surface elevations were taken at every transit station, bench marks being established at distances of about 1 mile apart. These bench marks were made on the roots of thrifty trees and marked by a 20-penny wire nail. At all important points two bench marks were established to render preservation of elevations more certain. There was practically no variation in the stage of the river during the survey. Owing to the necessity of pushing the survey as rapidly as possible, the depth of river was ascertained as follows: In crossing a passage between stations I paddled my own canoe, the transit being laid in a rest made for the purpose. The paddle used was 6 feet in length, having foot marks cut on the shank. Care was taken to cover a considerable portion of the river bed, constant soundings being made with the paddle.

The other boatmen were also instructed to make frequent trial of depths with their paddles. Wherever the river began to shoal and the depths in the channel showed less than 5 feet, special soundings were made with a sounding rod and all soundings noted. These soundings were continued until deep water was again reached. Where pools were long and deep, occasional cross sections of banks and channel were made and noted to show the average section of the pool. In most cases where soundings on the map are infrequent, the paddles did not touch bottom at all except close in at the banks. Practically, therefore, all depths of channel, except where soundings show otherwise, are 5 feet and over at extreme low water. All elevations are referred to precise B. M. 32 equals △ Obion of the Mississippi River survey, with which direct connection was made by a check line of levels. This elevation is referred to a plane 190.84 feet below the zero of the United States Engineers' gauge at Memphis, Tenn. A low and high water reference was made on the south end of the west doorstep of the county court-house at Dyersburg, Tenn. Five high-water marks were established between Dyersburg and the Mississippi River. The discharge of the Middle Fork was obtained by floats just below Dyersburg; of the South Fork at its junction with Middle Fork by a Buff and Berger current meter, and of Obion River one-quarter of a mile above its mouth by the same meter.

These observations were all made at an extreme low-water stage and with a stationary river, the elevation of water surface being carefully referenced on B. M. in each instance. The observations were of a necessity confined to a day for each point. This allowed of about 10 determinations on each station on the section, the stations being 10 feet apart. As the river bottom in each instance was very uniform, the channel straight, and there was no wind to interfere, it is believed the results will bear a very close approximation to the actual low-water discharge at the several points examined. The survey shows that part of the Forked Deer River comprised in the examination to be naturally divided into three sections.

1. That portion of the Forked Deer River between Dyersburg and Key Corner, a distance of 20 miles, with a fall of 6.58 feet.

2. That portion between Key Corner and the Obion River, a distance of 9¼ miles, with a fall of 15.77 feet.

3. The Obion River from Tiger Tail to the Mississippi River.

Section 1, between Chesapeake, Ohio and Southwestern Railroad Bridge at Dyersburg and Key Corner.—This portion of the river is good and in good condition. From Dyersburg to the junction of Middle and South Forks it will average about 65 feet in width. The banks, ranging in height from 8½ to 14 feet above low water, are very uniform and perfectly intact. There are no feeders to this portion of the river with the exception of a small branch at Dyersburg, and some small creeks and outlets to sloughs, which at this stage of the river are all dry.

Below the forks the river widens rapidly, ranging between this point and Key Corner from about 150 to 200 feet in width. An occasional sharp bend causes the river to narrow to 80 or 100 feet, but at these points the channel is generally clean and deep. The banks are uniform, intact, and show very little erosion; where erosion occurs it is always on the long side of rapid bends; at these points the banks have caved for some distance back; but this erosion seems to do but little harm, with the exception of pitching a few trees into the river. The channel at these points is always deep, and just now in the main free from obstructions, a snagging party having blasted out the worst of the snags and deadened all overhanging timber during the past summer. The banks along here will average 10 feet in height, at only two points reaching below 8 feet. These places are short, the lowest reaching to about 7½ feet above the low-water plane. Most of the country on the south bank a little way back from the river is under cultivation and is very rich; a large portion of the north bank is also cultivated. Virgin gum, cottonwood, ash, and oak forests still line the banks and extend for some distance back from the river. On almost the entire distance of 20 miles there are two bottoms on each side of the river, known as the first and second bottoms. The first bottoms generally form the bank of the river proper, and are yet covered with timber. The second bottoms frequently reach to the river, showing banks of from 12 to 15 feet in height; at all other points this second bank is from one-fourth to one-half a mile back from the river, where there is an abrupt rise of from 5 to 7 feet. This second bottom is in all cases under cultivation. There are several long sloughs, which parallel the river along here. These are for the most part some distance back from the river bank, and are connected with the river by narrow and deep outlets. Low cypress brakes reach to the river here and there, but in all cases they are surrounded by banks as high as those of the river in the immediate vicinity.

The bad portions of the river in this section are as follows:

1. Sunken saw logs obstructing channel at Stevens Lumber Company yards at Dyersburg. These logs have become partially embedded in the bottom of the river, and are great obstructions to navigation at low-water stages. They are the property of the Stevens Lumber Company; have been allowed to sink and remain in the channel by their carelessness, and should be removed by them.

2. One-half a mile below Dyersburg there is a very short and difficult bend, one-fourth of a mile in length. The river has already started a cut-off across the narrow neck of the bend, and has made a channel 325 feet long, which is navigable at ordinary high stages of the river. A very little work would render this cut-off navigable at all stages of the river and benefit navigation considerably.

3. Caney Point Shoal, 8 miles below Dyersburg. This is undoubtedly another natural cut-off, as the old channels above and below the shoals are clearly defined. Old maps show an island here, but the main river at some time evidently followed a much longer channel, as cypress knees are showing all across the present channel of the river. This shoal is very short, only 100 feet in length, and will now give 2 feet to extreme low-water navigation. The removal of the cypress knees and a few snags hung upon them will undoubtedly clear the channel here and deep water will result from the scour, as the water is very deep both above and below the shoal.

4. At Basin No. 1, 12½ miles below Dyersburg, the river shoals a little, but there is at least 3.5 feet of water here to extreme low-water navigation.

5. At Basin No. 2, 13½ miles below Dyersburg, there is another short shoal of sand. These shoals seem to be caused by the widening of the river and the extreme shortness of the bend at their foot. Two and one-half feet is found here for extreme low-water navigation.

6. Shoal at "cut-off" No. 2, 14½ miles below Dyersburg. This shoal is similar to the two above, but somewhat longer, and with a heavier fall. It is of sand, and results from the sudden curving and narrowing of the river at a very tortuous bend. The channel at low water is 2 feet deep. A cut-off has started here, through which water was running freely at time of survey. This cut-off is about 500 feet long, with a fall of 0.5 foot at extreme low water.

7. At McCoys Shoal the shallowest water on this portion of the river was found. The shoal is 14½ miles below Dyersburg, and will give but 1.5 feet to extreme low-water navigation. This shoal is caused by the sudden widening of the river above a short bend. It is of sand, and can be corrected by contracting the channel by any simple means. The fall here is slight, but sufficient for scouring, and the water at the foot of the shoal is very deep. The fall of the river at extreme low water in this

section of 20 miles is but 6.58 feet. With the exception of the points above named, the river is a fine, deep pool, some of the reaches averaging 12 feet and 14 feet in depth, practically free from obstructions and caving banks, and capable of easy and permanent improvement.

Section No. 2, from Key Corner to junction with Obion River.—This section of the river is nearly all bad. Key Corner is the last high ground on the river, and from this point it flows through the Mississippi River bottoms.

After passing Key Corner the river shoals rapidly; it is very tortuous; on every short side of a bend is a heavy sand bar, and there is more or less erosion on the long side of the curves.

The banks are for the most part a good height, but they are formed of the alluvial deposit from the Mississippi River, and are very unstable.

The trees along the banks are large, and stand thick on the ground. When a cave occurs, birch, gum, maple, willow, and oaks are pitched roots and all into the bed of the river. The river channel in this section of 9¼ miles is one mass of snags, sunken logs, and drift, whole trees being half embedded in the sand and standing 10 and 15 feet high in the bed of the river. The banks grow rapidly higher as the mouth of the river is approached.

The face of the country grows higher while the river is falling rapidly between the banks, and in the lower reaches these reach a height of from 30 to 32 feet above the low-water plane.

The slope of the river is very rapid for a river confined only by alluvial banks, the fall of the low-water surface in this 9¼ miles being 15.77 feet, or an average of 1.65 feet to the mile.

The causes which lead to this shoaling and heavy erosion are three in number.

1. The heavy deposits of sand and drift brought in by the Mississippi River and deposited between the high, straight banks through which the Forked Deer River flows. The digging of the canal by the State of Tennessee has doubtless caused this, the worst feature. The Mississippi River, when rising more rapidly than the Forked Deer, seeks the lowest points for outlet before overflowing the whole country. Naturally it draws to its old channel, now the Obion River, and following this passes into the Forked Deer River through the Tiger Tail Canal, finding its first outlet to the south through the old and lost channels of the Forked Deer River. These channels are now raised by the drift to a point 10 to 12 feet above the low water in Forked Deer River. We have here, then, a dam 10 to 12 feet high, with banks on each side 20 to 30 feet high, upon which the full current of the Mississippi beats when seeking outlet during high and rapid rises. It will readily be seen that all sand, silt, and subsurface drift striking this barrier is deposited here. Through this mass of sand and drift the Forked Deer River has to cut its way after the Mississippi has receded into its banks again.

2. The canal called Tiger Tail was cut through a high point of the bottoms and now runs between perpendicular banks 30 and 32 feet high. There has never been any vegetation upon these banks, a narrow canal being originally dug and the river left to complete the work. The trees which line the top and edge of the bank serve to help in the process of caving, which is rapidly going on. When the Forked Deer River is running out rapidly from a heavy head rise this erosion is tremendous, and the overhanging trees, which fall and become entangled in the already obstructed channel, only cause the deflected currents to do yet greater damage.

3. The pitching into the river of the trees along the banks and the massing of drift borne up by the Mississippi render the erosive power of the Forked Deer River nil, so far as the bottom of the river is concerned.

A glance at the map will show the true condition of the river. The bars as they approach the Obion River grow larger, averaging from 10 to 15 feet in height and being reenforced by masses of drift which have tangled together and been covered by the sand. These bars are constantly encroaching upon the present channel, and being much more durable and scientifically built, cause the river to cut out the softer banks opposite to them.

If the snags were removed, the river would probably afford about 2.5 feet to extreme low-water navigation; and if the embedded trees and snags could be blasted out and removed, there is no doubt but that the depth would be materially increased by natural erosion, as the current is very swift.

The work of removing snags, trees, and logs, to be of any practical benefit, should only be done at very low stages, as it is the embedded trees and logs that are preventing the scouring of the river channel.

The river widens materially at Tiger Tail Post-Office just before entering the Obion. It is very shallow and swift here. There is practically no boating channel at low-water stages. This shoal extends for some distance down the Obion River.

The cutting of the Tiger Tail Canal seems to have resulted only in the shoaling of both the Forked Deer and Obion rivers, the constant flow of sand from the bad

part of the Forked Deer keeping the Obion choked up and probably adding much to the agencies which caused the great bar to form across the mouth of the Obion River.

Section 3, Obion River from Tiger Tail to Mississippi River, a distance of 3.5 miles, with a fall of 4.20 feet.—With the exception of the bar across the river below the mouth of Forked Deer River, which will give 1.5 feet to extreme low-water navigation, and the great bar across the mouth of the Obion, this section of the river is very good. It is narrow, averaging from 60 to 100 feet in width, but very deep. The narrowing of the river here has been caused by the deepening of the channel by natural erosion and the consequent slipping in of undermined banks. In the Forked Deer River the banks are caving, in the Obion River slipping in. By caving is meant the total destruction of the face of the existing bank, earth and trees being precipitated into the river channel; by slipping in, the settling down of the banks, contracting the channel, but leaving trees embedded and oftentimes growing in the banks, changing the cross section of the channel and banks without diminishing the materials which formed them.

While the banks of the Obion look very rough, a careful examination leads to the belief that the slipping will not occur again for some time, if at all, the roots of the trees, which are leaning away from instead of over the river, forming a valuable protection to the banks in their present condition. Most of this slipping occurred in a very heavy head rise about four years ago.

There is some little snagging and removal of drift to be done in this section.

A sand bar has now formed across the mouth of the Obion in the Mississippi River. Through this the Obion River cuts its way for a distance of 2,000 feet. The bar is of sharp sand, 10 to 14 feet high, and has formed since the survey of the Obion River about four years ago. The average depth of water across this bar is about 2 feet at extreme low water. It is unsafe to venture in a rowboat to the point where the Obion enters the Mississippi at low water, the rush of the water being dangerous and the fall heavy.

All of the country below Key Corner and between the Forked Deer and Obion rivers is overflowed at high stages.

South Fork is crossed at Jackson, Tenn., by the Illinois Central, the Mobile and Ohio, and the Tennessee Midland railways; at Bells Depot by the Louisville and Nashville Railroad, and the Chesapeake, Ohio and Southwestern Railroad crosses the Middle Fork at Dyersburg.

The following small tables, it is thought, will be of use in examination of maps and profiles:

Localities.	Elevation of extreme low water.	Elevation bench marks.	Elevation high-water plane.	Distances from Chesapeake, Ohio and Southwestern Railroad Bridge.
	Feet.	*Feet.**	*Feet.*	*Miles.*
Chesapeake, Ohio and Southwestern Railroad Bridge	267.55	296.15	.....	0
Dyersburg	267.06	321.34	289.41	1
Cut-off No. 1	265.63	.....	.....	1.5
Cut-off No. 2	264.52	.....	.....	3.3
Caney Point	264.01	273.92	.....	8
South Fork	263.78	279.04	.....	8.5
Keno Bluff	263.55	279.56	.....	10
Basin No. 1	263.51	270.69	.....	12.6
Basin No. 2	263.29	275.90	.....	13.2
Cut-off No. 3	262.31	271.59	.....	14.3
McCoy Shoal	262.01	.....	.....	14.8
Scott Basin	261.02	.....	.....	19.2
Key Corner	260.97	282.03	282.62	20
Upper Hickory Landing	260.13	.....	.....	22
Skipper Cut-off	258.13	268.74	.....	24.4
White Oak Landing	256.64	267.94	.....	25.5
Bostwick Slough	253.60	.....	.....	26.5
Lost Channel	250.49	.....	.....	28.2
Tiger Tail	245.20	275.25	282.63	29.5
Ferry, Obion River	242.22	281.36	282.80	32.5
Mississippi River	241	.....	.....	33

* Base rail.

NOTE.—All elevations are referred to B. M. 32 equals △ Obion of Mississippi River Survey.

Data obtained from discharge measurements.

On sections.	Middle Fork at Dyersburg.	Mouth of South Fork.	Obion River at mouth.
Width of river.....feet..	58	64	133
Area.....square feet..	138.8	134.45	302.5
Discharge per second.....cubic feet..	147.882	194.732	610.440
Mean velocity per second.....feet..	1.065	1.448	2.018
Elevation W.S.....	265.42	263.79	242.00

NOTE.—Discharges taken at extreme low water and on stationary river. Conditions favorable. Whence, as there are no feeders at extreme low-water stage: Discharge main Forked Deer River, 342.614 cubic feet per second; discharge, Obion River, above Tiger Tail, 267.826 cubic feet per second.

Map of river, profiles of extreme low-water surface, channel of river and banks, and cross sections herewith.

Very respectfully submitted.

BENJ. B. SMITH, *Surveyor.*

Capt. JOHN BIDDLE,
Corps of Engineers.

APPENDIX B B.

IMPROVEMENT OF TENNESSEE RIVER AND ITS TRIBUTARIES.

REPORT OF CAPT. THEO. A. BINGHAM, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River.
2. Operating and care of Muscle Shoals Canal, Tennessee River.
3. Hiwassee River, Tennessee.
4. French Broad and Little Pigeon rivers, Tennessee.
5. Clinch River, Tennessee.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., July 8, 1895.

GENERAL: I have the honor to transmit herewith my annual report upon the river improvements, now under my charge, for the fiscal year ending June 30, 1895. * * *

Very respectfully, your obedient servant,

THEO. A. BINGHAM,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

THE DISTRICT.

From the beginning of the fiscal year until December 20, 1894, the Tennessee River above Chattanooga, Tenn., and below Bee Tree Shoals, Ala., and until January 14, 1895, the Hiwassee, French Broad, Little Pigeon, and Clinch rivers in the State of Tennessee, were under the charge of Capt. John Biddle, Corps of Engineers, with headquarters at Nashville, Tenn.

From the beginning of the fiscal year until October 4, 1894, the Tennessee River between Chattanooga, Tenn., and Bee Tree Shoals, Ala., was in charge of Capt. George W. Goethals, Corps of Engineers, with headquarters at Florence, Ala.; from that date to December 20, 1894, under charge of Capt. John Biddle, at Nashville, Tenn.

From December 20, 1894, and January 14, 1895, to the close of the fiscal year the works of improvement on the above-mentioned rivers, being the entire Tennessee River with its head-water tributaries in the State of

Tennessee, have been under charge of Capt. Theo. A. Bingham, Corps of Engineers, with headquarters at Chattanooga, Tenn.

Since October 9, 1894, Second Lieut. James F. McIndoe, Corps of Engineers, has been assistant to the engineer officer in charge, with station at Florence, Ala. He has been in immediate charge of surveys, gauges, physical data, bridges, and of the improvement of the Tennesee River above Chattanooga, including the tributaries.

The division engineers were Col. C. B. Comstock, Corps of Engineers, at New York, until February 5, 1895; since that date Col. Henry M. Robert, Corps of Engineers, at New York.

The historical parts of this report have been adopted from former annual reports of the engineer officers in charge of works of improvement on the various rivers now comprising this district.

SURVEYS.

A small steamer was chartered for the purpose of handling the quarter boats and a party organized on November 17, 1894, for the survey below Riverton, Ala., authorized by act of August 17, 1894. On account of the low stage of the river the steamer and the supplies could not reach Riverton, and the survey was therefore begun at Hamburg, Tenn., the highest point that could be reached. Operations were carried on from November 22 to December 17, 1894, when a rise in the river made further progress impossible and the party was discharged.

The following is a summary of the field work done:

Distance in miles covered (each bank)	37.5
Stadia stations occupied	597
Sets azimuth observations made	2
Temporary level bench marks established	77
High-water marks observed	8
Water surfaces taken	156
Ranges sounded over	475
Soundings located	4,923
Borings made and located	18

In addition to the above, level bench marks were established at 36 places between Riverton, Ala., and Hamburg, Tenn., and the water surface referred to each. Also, during the low water just previous to the survey, Assistant Engineer George W. Brown measured the discharge at Riverton, Ala., and Paducah, Ky., established 9 temporary gauges, and referred the water surface to 74 bench marks between these points.

Deducting amounts expended, but not properly chargeable to the work of the fiscal year because they were nonrecurring, the 37.5 miles surveyed cost very close to $55 per mile.

The transit notes were computed, ready for platting, by Assistant Engineer O. W. Ferguson, but the level and sounding notes have not been reduced, as Mr. Ferguson was sent into the field in April in charge of a precise-level party.

It is proposed to continue the survey during the coming low-water season as far as the available funds will permit.

PRECISE LEVELS.

No continuous levels have ever been made for the whole Tennessee Valley. Leveling has been done only where the scattered works have been carried out. Such levels as have been run had no connection with each other. No comparison has ever been possible between gauges read at considerable distances apart.

In order to introduce uniformity into this branch of Tennessee River work and at the same time to obtain data not only necessary for river work, but valuable as well for all this section of the country, as population and industry increase, the precise-level system of the Mississippi River Commission and of the Coast Survey has been extended to the Tennessee River. Bench marks of the Mississippi River Commission existed at Memphis. The Coast Survey had run a line of levels from Biloxi, Miss., on the Gulf, north along the Mobile and Ohio Railroad. They had also checked at Corinth across to the Mississippi River system at Memphis. Hence, Corinth was quite accurately determined.

Mr. O. W. Ferguson, an assistant engineer who has had long experience in precise-level work on the Mississippi and Missouri rivers and bears a high reputation as a specialist in that work, was secured and took the field April 20, 1895, at Corinth. The precise-level work followed the Memphis and Charleston Railroad to Riverton Junction, whence a branch line was run to Riverton, Ala., at the foot of Colbert Shoals and the site of the 25-foot lift lock.

From Riverton Junction work followed the railroad through Tuscumbia, touching the river north of Pride Station and reaching it again at Florence, Ala.

From Florence work was carried up the right bank of the Tennessee River, along the Muscle Shoals and Elk River canals, and by the end of the fiscal year had reached Decatur, Ala., a distance of 125 miles, covered in sixty working days, at an approximate cost of $18 per mile.

The remaining available balance, $1,650, will be expended below Riverton, Ala., and then this very necessary work must cease for the present.

The work is being done by two parties, each checking its own work.

The rods and instruments used were kindly lent by the secretary of the Mississippi River Commission, and it is highly desirable that sufficient funds ($10,000) should be provided for completing this work before the instruments have to be returned.

MAPS AND DATA.

Work has been begun on piecing together such surveys as exist with a view to locating the future surveys needed to complete a continuous map and profile of the Tennessee River.

The reach from Chattanooga to Bridgeport is almost complete, a part of the profile only being lacking.

The map from Decatur to Riverton can also be almost, if not quite, made continuous. The rest of the river below Chattanooga has never been surveyed.

All survey books, notes, and sketches of the district have been marked, indexed, filed, and made quickly available for use.

GAUGES.

Gauge and discharge records have been carefully gone over, gaps filled as far as was found possible, the records marked, indexed, and filed preparatory to the preparation of proper hydrographs and the graphical history of the river.

Gauge readings have been taken continuously during the year at head and at foot of Colbert Shoals; at Florence; at the pier and locks A, B, 1, and 9 of Muscle Shoals Canal; and continuously to June 30, 1895, at Decatur from May 10; at Bridgeport from January 7; at Kingston, on Clinch River, from March 11, 1895.

In addition there have been obtained and filed in this office all the records of the signal-service gauges at Knoxville, Loudon, Rockwood, Johnsonville, Strawberry Plains, Leadvale, Clinton, Kingston, Charleston, and Chattanooga, Tenn.

BRIDGES.

Having reference to the bridges spanning the Tennessee River, it was intended to make them the subject of a full report, accompanied by tables and drawings showing dimensions, etc., and the assistant engineers have been instructed to make the necessary surveys, but their reports can not be received in time to embody them in this report.

A general bridge law is much needed for the Tennessee River, clearly defining what facilities for the passage of boats must be complied with by companies owning or operating bridges over this river, and establishing penalties for violation.

It seems pertinent to quote the following from the annual report of Colonel Barlow for 1890:

> The number of bridges now spanning the Tennessee River, when taken in connection with the number proposed to be constructed under the recent enabling acts of Congress, forms a very important matter for consideration where the interests of navigation are concerned.
>
> All bridges are obstructions in a greater or less degree, and it is highly desirable that all new bridges be constructed with a view to securing in those having continuous spans a certain width and height above high water in their navigation spans, and in drawbridges a certain uniform width of clear waterway in their draw-spans.

The following tables show existing bridges and those authorized to be built by Congressional sanction over the Tennessee River:

Existing Bridges (12).

Location.	Operated by—
Knoxville, Tenn	Marietta and North Georgia R. R.
Do	County.
Do	East Tennessee, Virginia and Georgia R. R. (Southern).
Loudon, Tenn	Do.
Chattanooga, Tenn	Cincinnati Southern R. R. (Q. & C.).
Do	Chattanooga Bridge Co.
Bridgeport, Ala	Nashville, Chattanooga and St. Louis R. R.
Decatur, Ala	Memphis and Charleston R. R.
Florence, Ala	Do.
Johnsonville, Tenn	Nashville, Chattanooga and St. Louis R. R.
Danville, Tenn	Louisville and Nashville R. R.
Gilbertsville, Ky	Newport News and Mississippi Valley R. R.

New Bridges Authorized (13).

Location.	To be built by—	Date of act.
Kingston, Tenn., within 15 miles of junction with Clinch.	Fairmount Valley R. R.	Aug. 7, 1894
Chattanooga, Tenn	Chattanooga Western R. R. Co	Jan. 27, 1894
Guntersville, Ala	Huntsville and Birmingham R. R. Co	Mar. 3, 1887
Deposit, Ala	Curleys and Paint Rock Valley R. R. Co	July 30, 1892
Whitesburg Precinct, Alabama	Huntsville Bridge Co	July 27, 1892
Between Colbert and Lauderdale counties, Ala.	Mexican Gulf, Pacific and Puget Sound R. R. Co.	June 21, 1892
Foot of Muscle Shoals Canal, Ala	Tennessee Bridge Co	Mar. 3, 1887
Sheffield, Ala	Sheffield Land, Iron and Coal Co	Do.
Do	Tennessee Bridge and Ferry Co	Mar. 3, 1893
Do	do	Mar. 2, 1895
Clifton, Tenn	St. Louis and Birmingham R. R. Co	Apr. 21, 1894
Counties Perry and Decatur, Tenn	Nashville, Jackson and Memphis R. R. Co	May 17, 1893
Birmingham, Ky	Cairo and Tennessee River R. R. Co	Sept. 25, 1893

The removal of the rest piers of the bridge of the Newport News and Mississippi Valley Railroad Company at Gilbertsville, Ky., is reported by said company as completed. By direction of the Secretary of War the rest piers were to be wholly removed to a depth of not less than 6 feet below extreme low-water mark. The said company reports that the piers "have been removed to a depth of 6 feet or more below extreme low water," but verification by the engineer officer in charge has not been practicable up to the present time.

BRIDGE AT DECATUR, ALA.

This bridge is the worst on the river for steamboats to pass and is so dangerous, except under the most favorable circumstances, as to be fast assuming the character of a nuisance. The pivot pier is on shore and only one of the draws is therefore available. This draw has only 55 feet in the clear. Wind is on this river a serious obstacle to navigation, because boats have to be of such light draft as to have what may be styled very little hold in the water. Hence boats often become unmanageable when the wind blows at all hard, and have to tie up to the bank. It rarely happens that there is no wind and hence generally steamboats have to stop and pass through the Decatur draw with the greatest caution, often with men stationed on both sides to prevent striking the piers. When a steamboat has a tow of barges, this difficulty is much aggravated, and if the wind be blowing, even a little, it is often impossible to go down through this draw at all, because backing would be fatal. Coming upstream the most extraordinary care has to be exercised although there should be no trouble at all.

Other bridges, notably the one at Bridgeport, and in a less degree the one at Florence, have been made safe and convenient for boats, but all attempts have heretofore failed to make the Memphis and Charleston Railroad put the Decatur Bridge in proper condition, as demanded by the interests of the entire Tennessee River.

It is only equitable to all bridge owners that all should be compelled to give equal facilities for steamboats and that the broad-minded companies should not be under great expenses for necessary bridge changes which are successfully avoided by the contrary minded.

Moreover, the General Government has expended millions of dollars in assisting the navigation of this river, and is all this to go for naught on account of the refusal of the owners of one bridge to do what the interests of 675 miles of navigable river with all its tributary country imperatively demand?

June 20, 1895, a letter was received from Mr. Harvey Lewis, secretary and treasurer of the American Oak Extract Company, of Decatur, Ala., in which complaint is made by their captain, Rowden, of the steamer *B. F. Young* of the great difficulty experienced by him June 17, 1895, in getting through this draw at a fair stage of water, and asking how the railroad company can be got to rebuild the draw over the span next north instead of half over the shore, as it is now. Many other similar letters are on file in this office.

* * * * * * *

STEAMBOATS AND FLOATING PLANT.

The steamboat *McPherson* has been thoroughly overhauled and repaired, and with proper care should now last six years longer.

The upper cabin has been removed, all the crew being housed on the main deck. This is a gain in draft and in offering less resistance to

wind. The boilers and machinery have been put in good order, involving some very essential repairs.

A so-called "staggered" wheel of special design has been put on and causes the motion to be very steady.

This boat is a small example of what the towboats on this shallow river should be, drawing only 15 inches and able to make 6 miles an hour upstream.

The steamer *Colbert*, which was built to draw 18 inches, still draws less than 21 inches and has rendered valuable service in towing at all stages of water, thus illustrating what can be done on this river by properly designed boats.

Steamboating on the Tennessee River is very backward, both commercially and scientifically, and if improved technically would increase commercially. The necessity for the Government to have its own fleet in improving the river is evident to the casual visitor. But it has been difficult to secure good steamboat men, men used to handling lines, to getting over difficult places, used, in short, to accomplishing results besides being loyal and trustworthy. Effort has been made to remedy this defect and almost all the men needed have, after much delay and search, been secured.

Study of the conditions of boating on this river and observation made during such repairs to floating plant as have been found necessary, have led to certain apparently well-founded conclusions which it may not be improper to summarize briefly.

Below Riverton there is water enough at almost all stages for Mississippi and Ohio river steamboats and barges, or, at any rate, for those of them of lightest draft.

Above Riverton, as far up as Knoxville, towboats and barges should be designed to work easily in 3 feet of water, loading deeper when stage of water permits. Merchants say cargoes of 400 tons of through freight will pay. Then, instead of attempting to put this all on one steamboat, it must be spread out over a steamboat and one or several barges, taking 30 inches as deepest available draft during the low-water months.

This principle has been lost sight of in the recent additions to the upper river commercial fleet. In spite of many difficulties already experienced, however, the upper river people seem now convinced of the practicability of a through river traffic, and it seems probable that lighter draft steamboats will be introduced during the present year.

It is thought that the following may be regarded as correct:

1. Steamboats to work on the Tennessee River above Riverton should be got out on 20 inches draft, with coal bunkers full.

2. Since light-draft boats have little hold on the water and hence experience great difficulties from wind, these boats should be "one-story," not "full cabined," as it is called, with the necessary pilot house only above the main deck.

3. Since length and breadth are indispensable for the necessary light draft and powerful engines, room enough will be found on the main deck for housing the crew, with sufficient room besides for the few passengers carried, or for freight if no accommodations be provided for passengers.

4. Passenger and excursion trade can be most comfortably provided for by a separate one-story cabin boat, to be towed.

5. Freight should be carried on barges, which must and can easily be built, drawing 8 inches or less empty, and which will carry 200 tons and over on 24 inches draft.

6. To secure the above results all hulls should be "scow hulls;" that is, not modeled, but with easy rakes fore and aft. The heavy oak lumber is necessary only for lower sides of gunwales, the bottoms, and a few special parts. Instead of oak, yellow pine may well be used, provided it be free from too much pitch. It is, besides, much easier to get long lengths of yellow pine than of any other timber. All other parts of the boats to be preferably of yellow poplar or white pine.

7. It is believed that long-stroke engines will give better results on the Tennessee River than the shorter stroke, which are locally preferred.

8. If boilers, steam pipes, cylinders, etc., be covered with nonconducting material much coal would be saved. Such "packing" is now neglected on the Tennessee River generally.

9. A so-called "staggered" wheel will be found of advantage, especially in ascending shoals. This is a wheel in which the buckets are not continuous, but in bays, the buckets of one bay being set between those of the adjoining bays.

B B 1.

IMPROVEMENT OF TENNESSEE RIVER.

(Length, 673 miles.)

The junction of the Holston and French Broad rivers, 4½ miles above Knoxville, is now generally taken as the head of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the 53 or more tributaries of the Mississippi River, the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigable from its source to its mouth, a distance of 673 miles, during several months of the year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river so as to make navigation continuous throughout its entire length, for boats of moderate draft, is by no means an impossibility.

Now that the great obstruction of the Muscle Shoals has been overcome by the completed canal, and Colbert Shoals is in process of being done away with in the same manner, it is the more annoying to the now really brightening prospects for river navigation to have to contend with the smaller obstructions which exist in a number of places along the river. These obstructions are very short in length, but no whit less obstructive and at times destructive than the longer ones.

The improvements already attempted at many of these places have proved abortive because the localities have been worked on independently. In so far as work has been confined to removal of bowlders and snags it has been successful; but excavation, resulting in change of the conditions of flow, is very dangerous to attempt in river improvement unless long reaches above and below have been mapped, profiled, measured for discharge, and thoroughly studied beforehand. Without such preliminary study, hoped-for improvement from excavation is more

apt than not to result in developing obstructions at places which were navigable before.

Excepting for a sufficiency of discharge measurements, the necessary map and profile were made for the river above Chattanooga in 1891. For the river below Chattanooga many detached surveys exist which are now being patched together. About $5,000 is on hand for surveys below Riverton, but a continuous map and profile with discharge measurements taken at different stages of water is sadly needed for the entire river below Chattanooga. Gaps could be filled up and a continuous map completed for about $30,000. A comprehensive and logical plan for the complete improvement of the river will only then be possible. In this connection attention is respectfully called to remarks of this report under heading "5. Bee Tree Shoals to Paducah."

1. ABOVE CHATTANOOGA (188 MILES).

This section of the river is navigable during medium and high stages, which usually prevail through the winter and spring months, and occasionally at other seasons during the occurrence of so-called rain tides.

The navigation consists of steamboats carrying freight and passengers, flatboats bringing products from the upper tributaries, and rafts of logs and lumber, also brought from the tributaries, the latter constituting the major part of the commerce of the upper Tennessee River.

In 1830 Col. S. H. Long, U. S. Topographical Engineers, made a careful examination of the Holston and Tennesse rivers between Kingsport, Tenn., and the Alabama State line. His report, published as House Ex. Doc. No. 167, Forty-third Congress, second session, gives a detailed description of every obstruction to navigation at that time and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of Chief of Engineers, 1871, pp. 502–507, and 1872, pp. 488–494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements more or less permanent, with the exception of the removal from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams, but there is no record of the work done, and it did not prove of lasting value.

In 1850 Congress appropriated $50,000 for the improvement of this portion of the river, and the money appropriated was expended under the direction of Col. J. C. McClellan, Topographical Engineers, U. S. Army. Some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvements.

The present project of improvement is based upon the examination of 1871, and provides for the removal of snags and drift and for deepening the channel at the worst obstructions by blasting and dredging, or by scouring the bars, by the aid of wing dams, to an extent that will

secure a channel 3 feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891, for the reasons stated in the reports of those years.

Under the provisions of the river and harbor act of September 19, 1890, a "careful and comprehensive survey" of the Tennessee River above Chattanooga was made, "with a view of ascertaining to what extent the navigation of the river is capable of improvement, and the cost of the same, and the preparation of suitable plans therefor." This survey was begun in May, 1891, and completed during the fiscal year 1893. The report, with estimate and plans, was submitted to the Secretary of War in February, 1893, and forms House Ex. Doc. No. 252, Fifty-second Congress, second session. The plan of improvement proposed is the same as that now in progress, as above stated; that is, to obtain a 3-foot low-water navigable channel between Chattanooga and the mouth of the French Broad River, at an additional estimated cost of $650,000, the balance of the former estimates, $44,000, being wholly inadequate for the purpose, as can be readily seen by reference to the survey reports, forming part of annual report upon the improvement of the Tennessee River, 1893. If the present project—that of securing 3-foot low-water navigation—is to be carried out, a revision of the estimate of cost must of necessity be made in accordance with the data given in the survey report of February, 1893, submitted to Congress for its consideration.

Seventeen appropriations have been made by Congress for this work, aggregating the sum of $346,000, viz:

Act of—		Act of—	
July 11, 1870	$35,000	August 2, 1882	$7,000
June 10, 1872	25,000	July 5, 1884	3,000
March 3, 1873	25,000	August 5, 1886	7,500
June 23, 1874	25,000	August 11, 1888	15,000
March 3, 1875	40,000	September 19, 1890	30,000
August 14, 1876	15,000	July 13, 1892	25,000
June 18, 1878	15,000	August 17, 1894	50,000
March 3, 1879	11,500		
June 14, 1880	10,000	Total	346,000
March 3, 1881	7,000		

The amount expended, including outstanding indebtedness, to June 30, 1894, was $295,558.76. This expenditure has resulted in giving a lengthened season of navigation and an improved channel at 29 of the 43 obstructions enumerated by Colonel Long in his report of an examination made in 1830. Operations have consisted generally of excavating rock and gravel from the channel and building stone dams where necessary to give increased depth over reefs and shoals. It is reported that the work done at White Creek Shoals was rendered specially advantageous by causing the removal of the sand bar to deep water, "and it is believed that it is not likely to re-form for many years in the navigable channel." The channel and reefs at Soddy Shoals were examined and good progress made in drilling and blasting the rocky ledges forming this obstruction. The work is giving satisfaction to the navigation interests. Work was also resumed at Caney Creek Shoals by opening quarry on the south bank at head of shoals and quarrying stone for the necessary riprap dams. Quarrying was continued until July 10, 1893, being the only work done during the fiscal year of 1893–94.

Work was resumed at Caney Creek Shoals in September, 1894. Owing to extremely low water only a part of the necessary fleet could be taken there, and owing to the absence of the steamer *Long*, which

had been taken to the Cumberland River in March, 1894, such boats as were in use had to be moved by hand, thus delaying the work. This work was mainly channel excavation, with a small amount of dam building. The excavated channel was marked by 30 buoys and 2 beacons, and the work accomplished has given satisfaction to pilots, preventing a serious accident in one case to the steamer *Wyeth City* and tow during a heavy fog.

October 13, 1894, the water at Caney Creek became too cold for the men to excavate in it, and the projected dams were begun and continued with some intermissions until December 20, 1894, when the boats were moved to Kingston, Tenn., on the Clinch River, a good winter harbor.

The following is the detailed statement of work done at Caney Creek Shoals during 1894–95:

Trees cut		383
Logs and snags removed from channel		400
Stone quarried	cubic yards	1,364
Channel excavation, solid rock	do	430
Channel excavation, loose rock	do	164
Dam built, riprap	do	1,463
Bank riprapped	do	308
Buoys anchored		30
Beacons set		2

In January, 1895, the steamer *Long* returned with tow and joined the rest of the fleet at Kingston.

Plans were made for putting the fleet in good order and building a drilling raft for a No. 5 Rand steam drill. This work was begun early in April, 1895, and before the end of May the fleet was moving in sections to the French Broad River to do some little work of repairs to dams before the water because low enough to resume operations at Caney Creek.

The amount expended during the fiscal year 1894–95, including outstanding indebtedness, was $9,951.03.

The amount available and the balance of the estimate heretofore submitted can be profitably expended during the fiscal year 1896 in prosecuting the work under the project for obtaining a 3-foot navigable channel at low water between Chattanooga and the mouth of the French Broad River, by continuing channel work at Caney Creek Shoals and at such other obstructions as may be hereafter selected.

Money statement.

July 1, 1894, balance unexpended	$2,744.17
Amount appropriated by act of August 17, 1894	50,000.00
	52,744.17
June 30, 1895, amount expended during fiscal year	9,049.37
July 1, 1895, balance unexpended	43,694.80
July 1, 1895, outstanding liabilities	901.66
July 1, 1895, balance available	42,793.14

Amount (estimated) required for completion of existing project	600,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	65,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Cost of work done, Caney Creek Shoals, upper Tennessee River, September and October, 1894, including labor, materials, and subsistence.

Cutting trees, 383, at	$1.12
Removing logs and snags from channel, 400, at	.66
Quarrying stone, 1,364 cubic yards, at	.72
Excavation, channel, solid rock, 430 cubic yards, at	2.59
Excavation, channel, loose rock, 164 cubic yards, at	1.51
Riprap dam, 1,463 cubic yards, at	.73
Riprap on bank, 308 cubic yards, at	.44
Buoys, 30, at	6.88
Beacons, 2, at	2.81

Cost of work at Hanging Rock Shoal, French Broad River, June, 1895, including labor, materials, subsistence, etc.

Quarrying 1,320 cubic yards, at	$0.65
Riprap dam, 1,465 cubic yards, at	.80

2. CHATTANOOGA, TENN., TO DECATUR, ALA. (180 MILES).

The serious obstructions to continuous navigation through this section of the river are Ross Towhead, Burris Bar, the Suck, the reefs opposite Bridgeport, Ala., including Island Bar, Widow Bar, Guntersville Bar, Beard Reef.

The approved project for this section of the river is "to remove obstructions so as to secure a depth of at least 3 feet at low water."

The total amounts expended on this section of the river since July 1, 1891, are as follows:

Locality.	July 1, 1891, to June 30, 1894.	Year ending June 30, 1895.	Total for four years.
Ross Towhead	$22,625.33	$1,143.34	$23,768.67
Suck, including Tumbling Shoals, etc	56,168.50		56,168.50
Bridgeport, Ala	28,228.70	9,261.34	37,490.04
Guntersville and Beard Reef	2,060.42	1,403.10	3,463.52
Total	109,082.95	11,807.78	120,890.73

This expenditure has resulted in the removal of bowlders, gravel, snags, etc., and upstream navigation has been rendered somewhat easier than it formerly was. The dangers attending downstream navigation have been materially, if not entirely, remedied. The work done has, however, unavoidably been entirely local in its character, with little or no regard to the study of interdependent obstructions. There is no continuous survey and profile of this part of the river, although of the reach from Chattanooga to Bridgeport a nearly complete map has been pieced together.

Before further work in this part of the river is extended a complete survey with profile, levels, soundings, gauge readings, and discharge observations is urgently needed on which to base a comprehensive and rational study of the best plan to be adopted for improvement, both from an engineering and from a financial standpoint.

Ross Towhead.—This divides the river about 1 mile below Chattanooga into two portions; the right bank chute, which was generally used during the medium and higher stages, was not navigable during low water because of rock ledges extending across to the towhead. Under the original project of improvement the left bank chute was selected for navigation, and to increase the depth of water two riprap

dams were built in 1873–74; one extended from the head about two-thirds across to the right bank; the other from the foot of the towhead downstream longitudinally for 400 feet. Gravel washed from above had accumulated at the foot of the longitudinal dam until at the close of the fiscal year 1893 a gravel bar connected its extremity with the left bank. Only about 18 inches were available at low water.

Annual Report for 1894 says:

From the relative velocity and direction of the currents through the two chutes at Ross Towhead, at various stages of the river, it was evident that a sufficient depth at low water could not be maintained in the old channel to the left of the towhead, and this, together with the fact that the best water above and below the obstruction was along the right bank, led to the adoption of the new channel along the right bank. The channel was to be, when completed, 150 feet wide, straight throughout, from deep water above to deep water below, and to have 3 feet depth at low water, the amount excavated being determined by a series of gauges located along the line of excavation. The old chute was to be closed by a riprap dam at the head of the island formed by the excavated material, made tight by gravel backing, and raised to the height of 6-foot stage.

At the close of the fiscal year 1894 the work was being done by contract with W. A. Kirk, of Madison, Ind. The necessary drilling was done by hand from platforms when practicable and when season and stage of water permitted by men standing on the river bottom, a tripod dam being used to break the force of the current. The ledges were blasted and material removed by dipper dredge. Low water delayed the work and the contract was extended to December 25, 1894. Work was resumed by contractor July 13, 1894, and closed down November 15, 1894; 1,842.58 cubic yards of rock were removed at a cost of $3.75 per cubic yard and 269 cubic yards of gravel at a cost of $1 per cubic yard.

During August a survey was made in order to estimate the material still to be removed. It cost $15.60.

Monthly report for November, 1894, by the inspector says:

A number of prominent steamboat masters and pilots visited the work and sounded over it. They were greatly pleased with the entire work and all pronounced it to be one of the best chutes on the river.

Dissatisfaction has, however, since been heard of among river men, and it seems possible that a few pieces of rock may have been overlooked and not removed. During the week ending June 8, 1895, a steamboat with two barges in tow struck a rock and knocked a hole in the bottom of one of the barges. It is believed, however, that the boat was not in the channel, and as similar accidents and groundings occur from time to time it is intended to provide all excavated channels with buoys or beacons (which could be lighted at night should it ever be necessary). This has been done on the upper river, but never yet so far as is known on the lower river.

Total amount expended during the year was $1,143.34.

Burris Bar.—Williams Island, about 7 miles below Chattanooga, divides the river into two chutes. The present low-water channel is the right bank chute. This channel is obstructed by Burris Bar, consisting of ledges of rock entirely across the channel. The bar is about 1,800 feet across, up and down stream, and has an available depth at extreme low-water mark of about 1 foot. The left-bank channel is obstructed by a short reef at the head and by snags and bowlders. No work of improvement has been done here.

The Suck.—This is the name commonly applied to the several rapids and shoals where the river winds in a tortuous route through the mountains below Chattanooga, covering a distance of 8.5 miles, in which the

fall is 16.5 feet. The obstructions, separated by pools, are known as Tumbling Shoals, Suck Point, the Suck, Pot, Skillet, and Pan, and are formed by rock reefs and bowlders and by projecting rocky points from both shores, which contract the waterway.

At low-water stages Tumbling Shoals and the Skillet are especially difficult to navigate. As the river rises Suck Point and the Suck become difficult to stem, while the Pot and Pan are very great obstructions during high water.

The channel work carried on in 1869 and 1870 at the Suck and Pot and in 1889 at the Pan consisted in widening the cross section by the removal of bowlders, projecting rocky points, and overhanging trees, and has resulted in somewhat diminishing the velocity of the current. But upstream navigation is still attended with delays, caused by the necessity of laying lines and warping vessels over the swiftest places.

No work was done during the fiscal year. Some dredging is still to be done at Tumbling Shoals to complete the improvement as thus far projected.

Reefs opposite Bridgeport, Ala.—The river near Bridgeport, Ala., is divided into two chutes by Bridgeport Island, about 5 miles long, the left-bank chute being the steamboat channel. The obstructions consisted of a gravel deposit near the head of the island and limestone reefs above the railroad bridge and near the foot of the island.

At extreme low water the available depth was about 18 inches. The fall is about 1 foot to the mile.

During the fiscal year ending 1894 work at the head of the island resulted in a completed channel 120 feet wide and averaging about 6 feet deep. This increased depth was given to allow for drawing off the water, which will result when the bars in the same chute below are excavated.

Just above the railroad bridge one cut had been made through the bar at the close of the fiscal year 1894, resulting in a channel 1,800 feet long, 40 feet wide, and 5 feet deep.

Work was resumed here in November, 1894, and continued until the close of this fiscal year, with many interruptions, due to cold weather and too high a stage of water.

The obstructions are gravel and bowlders, and the project is to dredge these out to form a channel 120 feet wide and 3 feet deep at low water.

The work done in 1893–94 was suspended before all the bowlders found were removed from the channel.

During 1894–95, 200 of these bowlders, amounting to 64 cubic yards, were removed, some of them requiring to be drilled and blasted.

This work cost $266.57, or $4.16 per cubic yard.

The material dredged in 1893–94 had been dropped by the dredge outside of the cut, and this in 1894–95 was rehandled and placed outside the proposed channel as the foundation of a projected longitudinal dam intended to confine the water to the narrow dredged channel and also to back the water up the chute, the conditions of slope permitting this to be done. This double handling of the material dredged seems to be the cheapest way to do the work, for proper plant is not available for carrying the bowlders and gravel excavated at once to their place. The excavation was found to be of the most difficult kind, the gravel being filled with huge bowlders, which strained and often broke the dredge machinery, necessitating constant delay and repairs. Mr. W. S. Winn, the assistant engineer in charge, showed great perseverance under the frequent annoying rises of the river, which suspended work, and the intense cold of the latter part of December and

of January. The presence of these bowlders also necessitated dredging to more than the otherwise required depth in order to remove them.

Three thousand and three cubic yards of bowlders and 4,578 cubic yards of clay, sand, and gravel were dredged during the fiscal year, at an average cost of 35 cents per cubic yard for rock and gravel combined.

The accomplishment of the above dredging involved a great deal of repairs to the dredge, which is really too light for such heavy work. The dipper handle broke, spuds had to be renewed, and great difficulty was experienced in getting timber long enough for these repairs. The maneuvering chains had almost daily to be repaired, owing to the violent shocks sustained.

A few snags were also removed from the channel at this point, also a sunken barge, at a cost of $27.80.

Island Bar.—By September 13, 1894, the necessary boats had been brought up from Muscle Shoals Canal and work begun at Island Bar. This is 1.5 miles below the Bridgeport Bridge and extends half a mile downstream across both chutes. In the left bank chute the obstruction is solid limestone reef, crossing the chute at an angle, and about 600 feet across, up and down stream. Below this are bowlders, sand, and gravel.

The project is to excavate a channel 120 feet wide and 3 feet deep at low water.

A tripod dam 180 feet long, in 15 bays, was used to break the force of the current, and was moved four times as work progressed.

Eight hundred and eighty-nine and seven-tenths cubic yards of solid rock and 21 cubic yards of gravel were excavated by drilling and blasting, and removed by wheelbarrows, at an average cost of $4.16 per cubic yard for rock and gravel combined.

A channel 80 feet wide and 2 feet deep at low water was obtained for the distance of 600 feet. This gave 12 inches more depth of water over the reefs than ever before, and 4 inches more over the reefs than over the gravel bar below.

In the right-bank chute on the other side of Bridgeport Island the rock reefs appear again at seven distinct spots within a channel length of 200 feet. Each reef is about 6 feet thick and between the reefs the water is deep enough. Thirty-five cubic yards of rock were removed, at an average cost of $4.16 per cubic yard, and 390 overhanging trees were cut, at an average cost of 12½ cents per tree.

Work here was stopped November 1, 1894, owing to the coldness of the water.

Widow Bar.—This obstruction, a rock reef, is about 2.5 miles below Bridgeport Island and is about 2,800 feet in length, the depth of water over it varying from 1.5 to 2.5 feet at low water.

Guntersville Bar.—The river just above Guntersville is obstructed by bowlders and loose detached rock, making the steamboat channel very tortuous and difficult of passage during low water. Navigation is further impeded by a rock ledge 300 feet across, on which there is a minimum depth of 1 foot at low water.

The contract with Neely & Smith for removing material at this obstruction had been extended to November 15, 1894, the contractors having been unable to do any work, owing to sudden and frequent fluctuations of the water surface, which resulted in twice washing out their temporary tripod dam before any work could be done. This dam was used to deflect and lessen the force of the current, so that men could stand on the river bottom to drill.

On application of the contractors and by authority of the Chief of Engineers it was proposed to complete this work by the aid of a United States dredge not in use, reasonable allowance being made for same. This dredge was on its way to this locality at the end of the fiscal year 1894.

Slow progress was made with the dredge, however, which was the same one used later at Bridgeport, as described above. The difficulties of the work were the same as described above for Bridgeport. The dredge was abandoned, and by November, 1894, the water had become too cold for laborers to stand in, and work here was abandoned by the contractors.

Beard Reef.—This obstruction is about 3 miles below Guntersville Landing and consists of a rock ledge crossing the river normal to its banks, with a gap near the right bank, used as a steamboat channel, but obstructed by detached rocks.

A small force was put to work at the end of October, 1894, to remove points of reef and bowlders and give relief to transfer steamboats. A tripod dam 30 feet long was used to deflect and break the force of the current while men worked in the water. This was moved twice as work progressed and four times to allow the passage of boats.

Sixteen cubic yards of bowlders, one large bowlder not measured, and two logs were removed from the channel, at a total cost of $211.05.

Other obstructions exist between Guntersville and Decatur, but their exact nature and extent are not known, as this portion of the river has never been surveyed.

3. DECATUR TO FLORENCE, ALA. (50 MILES).

The principal obstructions are the Muscle Shoals, extending from deep water at Brown Ferry to deep water at Florence, a distance of 38 miles (only 8 of which are navigable), and embracing Elk River Shoals, Big Muscle and Little Muscle shoals.

The object of the improvement is to make continuous navigation around these obstructions by means of a lateral canal.

The approved project according to which work is being done, based on the survey of 1872, and somewhat modified in 1877, is:

(1) To enlarge, rebuild, and straighten the old canal around Big Muscle Shoals, built by the State of Alabama in 1831–1836 and abandoned in 1837, by constructing a canal 14.5 miles long, having nine locks, with a total lift of 85 feet and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long and 60 feet wide, with a depth of 5 feet of water on the miter sills.

(2) To construct at Elk River Shoals a canal 1.5 miles long, with two locks, having lifts of 12 feet and from 8 to 11 feet, respectively, and of same dimensions as the locks at Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed rock of the river and to construct stone wing dams and retaining walls to contract the waterway and to check the velocity of the current at certain points, as modified in 1880; to construct a lateral canal on the north bank, 15,000 feet long, with a guard lock at the head and a lock at the foot, having a lift of 12 feet and of same dimensions as the locks at Big Muscle Shoals.

Up to the close of the fiscal year ending June 30, 1895, $3,067,341.18 had been expended with the following results:

The two divisions of the canal were sufficiently completed to permit navigation at all stages of the water; channels were excavated through

Brown Island Chute, Gilchrist Chute, and Nance Reef; houses were built for occupancy of lock masters and assistants; a dredge and towboat were constructed, and a large amount of plant purchased for the necessary and immediate uses of the canal.

The channel through Brown Island Chute is very crooked, and was meant to be only temporary, as being the quickest obtainable. The proper channel is the one proposed along the left bank of the river.

Gilchrist Chute and Nance Reef have only 18 inches over them at low water. Work must be done to increase this to at least 3 feet before the canal work already accomplished can be regarded as finished.

Through Little Muscle Shoals the water gets below 3 feet at low stages, but no channel work is deemed advisable in view of the proposed lateral canal.

At Sweetwater, 1 mile above Florence, is a gravel bar which gives trouble at low water, but can easily be dredged out. It is formed by the wash of a small winter torrent emptying into the chute at this point.

At the lower end of the canal, just outside of Lock 9, "Galloping Shoals," as it is called, produces a strong eddy in the entrance pool below the lock. Sand and gravel are deposited thereby and a very troublesome, and at times dangerous, swirl exists. It is proposed to remedy this by a riprap wing dam starting opposite the lower corner of the lock and extending out into the river at an angle of about 36° for 360 feet. The outer end of the dam is to be sloped off in all directions in order to flatten out the surface of the water as much as possible. This project was approved May 7, 1895, and work was begun May 16, 1895. The dam is to be raised at first only to the height of ordinary low water in order to see if that will prove sufficient. The dam is estimated to contain 6,877 cubic yards and to cost $8,322, or $1.21 per cubic yard.

The following has been done:

	Cubic yards.
Quarry stripping	40
Stone quarried	1,305

4. FLORENCE, ALA., TO FOOT OF BEE TREE SHOALS (30 MILES).

Bee Tree and Colbert shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during low water.

These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, at which stage the available depth is about 1.5 feet.

Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The project adopted in 1890 contemplates the construction of a lateral canal on the south bank of the river 7.8 miles long, 150 feet wide at the water surface, with a depth of 7 feet. A combined lock, with a total lift of 25 feet, was originally intended to be placed at the lower end and a guard lock at the head for use when necessary at very high water, the locks to be 80 by 350 feet, with a depth of 6 feet on the miter sills at extreme low water.

This project was modified, after the detailed surveys of 1891 were completed, by substituting for the combined lock two locks of 12 and 13 feet lift, respectively, at extreme low water, separated by a pool 1 mile in length.

This project was again modified in 1892 by the substitution of one lock of 25 feet lift for the two locks contemplated in the project as modified in 1891, retaining the guard lock at the head of the canal.

Under the project $48,491.64 was expended up to the close of the fiscal year 1894, in making survey of location for canal, purchase of lands necessary for the improvement, examination of foundations for both locks, and for beginning by contract the construction of the lift lock.

Work done during the fiscal year 1895 was as follows:

Purchase of right of way was continued slowly, owing to delay in the necessary legal proceedings. About 80 per cent of the necessary land has been purchased and cession of jurisdiction by the State of Alabama obtained.

In April, 1895, work was begun on the design of the guard lock. Special study has been found necessary owing to the fluctuating conditions which affect this lock. Cross section study and general outline of the lock construction have been completed, and detailed drawings and memoir will probably be ready to be submitted for approval before October 1, 1895.

Examination for foundations of the guard lock was made in 1894. Although the exact location of this lock has not yet been settled, the test pits were so located that the greater number of them, if not all, are in the ground which must necessarily be covered by the lock. In order to avoid trouble from quicksand and water the work was done in a dry season and at very low stage of water.

Six pits were dug, 6 feet square and curbed. They were carried down to foundation rock, and from 2 to 3 feet of this rock was blasted and removed. A hole was then drilled 7 feet below this so as to leave no doubt as to solidity of the foundation. A number of pieces of the rock removed were exposed to alternate freezing and thawing during five months with apparently no effect. Judging from experience at Muscle Shoals, this rock should not be used for culverts unless covered by concrete or otherwise protected from flowing water.

Results of test pits.

Material.	Thickness of strata. Number of pit. 1n.	2n.	3n.	4s.	5s.	6s.	Average thickness.	Weight, per cubic foot.	Remarks.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Pounds.*	
Surface soil	14	13	9.5	11.5	9	14	11.83	80	Average.
Sandy loam	1	1	3	3.5	5.5	1	2.5	97.5	Packed.
Blue sand	2	4	3	1.75	2.5	3.75	2.83	115	Packed, quicksand.*
Gravel	2	2	1.75	.1	1.5	1.25	1.43	127.8	Coarse, partly cemented.
Depth to rock	19	20	17.25	16.85	18.5	20	18.6	.....	
Reference of rock	32.8	35	31.8	35.9	33.9	34.3	33.9	.....	
Reference of water	28.8	29	28	30.6	29.9	29.3	29.2	.....	
Height of water above rock.	4	6	3.8	5.3	4	5	4.7	.....	

* If kept drained to be handled without difficulty.

Water was met at an average depth of 14 feet below the surface, but two men could always keep the pits bailed out. The effect of river water upon water in the pits was ascertained by erecting gauges in Pits 3n and 5s. These were read simultaneously with Gauge No. 1 from November 18, 1894, to March 16, 1895. The results thus obtained were very irregular and of no particular value, except to show that the water

in the pits was affected as much, if not more, by a swamp to the south as by the river to the north. Some of the irregularities were probably caused by surface water.

In connection with this work a rough test was made at Muscle Shoals Canal for the value of coefficient c in the formula for emptying and filling locks:

$$t = \frac{2A\sqrt{H}}{ca\sqrt{2g}}$$ in which—

A = area of horizontal cross section of lock;
a = area of culverts;
H = head of water on culverts;
t = time of filling or emptying lock, in seconds;
c = coefficient of discharge.

Results obtained were:

	A	a	H	t		c
				Filling.	Empty-ing.	
				Seconds.	*Seconds.*	
Lock 1	18,216	2(22.28)	3.35	300	300	0.62
Lock 2	18,216	2(19.36)	7.2	420	480	.70
Lock 5	17,974	2(22.28)	11.8	600	540	.61
Lock 6	17,960	2(22.28)	12.9	660	480	.65
Lock 7	17,980	2(22.28)	11.6	540	450	.70
Lock 8	18,000	2(22.28)	9.8	450	480	.675

The larger values of c are probably the more correct as small values are caused if valve be not opened true to middle position.

At the lift lock at Riverton the contract for construction with Tere A. Clark, dated August 10, 1893, was in force at the beginning of the fiscal year and work was being done.

Operations under this contract were continued with ever-increasing difficulties and diminishing results until December 17, 1894, when the contractor ceased all active work, owing to a strike among his employees. The contract was annulled in January, 1895, and by February 1, 1895, the United States had assumed charge of the work. Comparatively little had been accomplished by the contractor, his efforts having been principally confined to excavation of lock pit.

From July 1 to August 18, 1894, wheelbarrows were used exclusively. Subsequently material was excavated by hydraulic jet and conveyed from the pit by a 9-inch centrifugal pump discharging on the river bank north of lock pit. The water for the excavating jet was forced into the pit from a small reservoir at the northeast corner of the lock site by a hydraulic pump, the reservoir being supplied from the river by an 8-inch centrifugal pump.

This method of excavation was not at all satisfactory. The velocity of the stream from hydraulic pump was not sufficiently great to carry the material to the discharging pump for a greater distance than 100 feet. The pit being about 600 by 130 feet, the greater portion of the material was handled three or four times before final discharge. This excavating plant was operated night and day besides.

Work done by contractor during fiscal year.

	Cubic yards.
Excavation, earth and gravel	26,000
Stone delivered at lock site, sandstone rubble	441
Stone delivered at lock site, granite quoin stone	24
Stone cut at lock site, rubble	879
Stone cut at lock site, fine pointed	27

Kellar's (or Bowser's) quarry.—Excepting the sandstone which came from Cherokee, Ala., and granite which came from Lithonia, Ga., all stone described above as at lock site was quarried by contractor at the above-named quarry, which is 25 miles above Riverton on south bank of Tennessee River. This quarry was abandoned by contractor in November, 1894, leaving on hand there the following estimated quantities:

	Cubic yards.
Fine-pointed stone	563
Rubble backing	518
Rough stone quarried sufficient for—	
Fine pointing	600
Backing	200

The piling used by contractor for sustaining the walls of the excavated lock pit and for confining quicksand is described in Annual Report for 1894. During fiscal year 1895, 287 piles and 402 linear feet of sheet piling were driven. The tops of revetment piles were also tied back to a line of anchor piles, driven 40 feet back from the face of the pit. As excavation progressed it was found necessary to brace the piles from the inside, their toes having penetrated the gravel only a few inches. About 130 linear feet was thus braced on the south side before work was abandoned.

January 7, 1895, the revetment on south side of lock pit began to yield, and soon the greater portion had fallen in, the piles breaking about in their centers.

January 13, 1895, the levee around lock pit gave way at the northeast corner where the suction pipe of the force pump passed through it, and the lock pit was flooded.

The contractor also did the following miscellaneous work:

Cut stone and backing were piled southwest of the lock site; the course of Chickasaw Creek was diverted in order to form a dumping ground for material excavated from the pit; the traveler, for handling stone in the stonecutter's yard, was taken down and moved to a more convenient point for handling stone arriving by rail from the Cherokee Quarry.

Work done by the United States for contractor.—By reason of the strike the contractor was unable to secure the necessary workmen to protect his plant from the high water of January, 1895. Upon the request of the receiver for Tere A. Clark, the United States employed men in January, 1895, to complete levees and otherwise protect plant. After the annulment of the contract and by similar request of the said receiver, the United States removed the plant and stored it safely outside the Government right of way. Following are details:

	Cubic yards.
Excavation, loose rock from site of levee	125
Excavation, earth for building levee	1,120
Miscellaneous:	
85 cubic yards cut stone repiled to prevent damage from unequal setting.	
Pumping plant, which had been damaged by freezing weather, put in order and lock pit pumped dry.	

The following amounts of stone, received from the receiver from Kellar's quarry, have been unloaded and piled in the yard:

	Cubic yards.
Fine pointed	150
Rough pointed	1.5
Backing attached	102
Backing rough	109.6
Backing dressed	34
Total	397.1

The above involved setting up two hoisting engines, one on the dock and one at the piling derrick, together with the placing of the necessary steam and water pipes for operating the engines.

Work done by the United States.—Previous to the annulment of contract, an assistant engineer and stone inspector were employed for superintendence and inspection of work performed and material used by the contractor.

Tests were made of contractor's cement, the Belgian Eagle brand, and report submitted March 29, 1895. It was much below standard and not uniform.

Detailed drawings and specifications for lock-gate anchorages were made, contract for same let to the New Jersey Steel and Iron Company, of Trenton, N. J., and the same have been delivered at lock site.

Detailed project for completing the lock has been made and approved. The purchase of the approved plant is almost completed, involving detailed specifications and drawings on which to call for bids. More than half the plant is on the ground and partly set up. Another month will complete this part of the work.

Tests of various brands of Portland and natural cements are being made.

Detailed drawings of special stones and other masonry are being made.

A water tank of 7,000 gallons capacity has been erected at the lock site, supplied by a 2-inch pipe from a spring 2,300 feet distant. Connections with all boilers at lock site have been made. Pumping plant consists of a 9-inch centrifugal pump of 2,600 gallons per minute, operated by a 35-horsepower stationary engine, steam being taken from a 60-horsepower boiler, used also for other engines. This pump is in working order at northwest corner of lock pit and is intended to drain the entire pit.

There is also on hand a duplicate pumping outfit ready for use in case of need.

An L-shaped storehouse has been erected for receiving material from railway switch and transferring to storerooms or to the construction cars. It contains tool room, cement storeroom, office, blacksmith and machine shop. These shops have been fitted with three forges, a drill press, and other necessary appliances operated by a 10-horsepower stationary engine.

Levee protection amounting to 1,304 cubic yards of earth has been completed for the lock pit and stone yard on all sides except the west. This end has been left open for the operation of construction cable road. This opening can be securely closed in one day if necessary, by a tripod and canvas dam for which the material is all ready.

Earth work.—In order to prepare for erecting derricks and laying the necessary tracks in the lock pit for the construction of the walls, it was necessary to transfer all of the loose gravel and earth left in the pit by the contractor to the north side of the lock.

Grading for tracks of overhead traveling cableway and for construction of inclined cable road has been completed. Stone yard has been cleaned up and leveled. Sand and gravel have been excavated from lock pit at location of the pump in order to drain water to this point. The above work involved 8,257 cubic yards of excavation and 2,489 cubic yards of embankment.

Six hundred and eighty-three cubic yards of solid rock have also been excavated from the lock pit.

Miscellaneous.—Two thousand one hundred and one cross-ties have been made and delivered at the lock site and distributed; 4,600 feet of track have been laid and surfaced up for overhead cable traveler and inclined construction cable road. Tripod and canvas dam, 180 feet long, was built and placed at opening between levees, as a protection against high water in March, 1895, and removed when water receded. Stationary engine, forge, blower, emery wheel, and shafting with pulleys have been erected in blacksmith shop.

Seventy-three tons of coal were unloaded and placed, repairs were made to pump and engine purchased from contractor, patterns were made for stonecutters, landing for steamboats cleared at lock site, cableway engine and boiler have been unloaded and set up.

Stonework.—Two stiff-leg derricks have been set up in the stone yard temporarily until the arrival of the traveling crane already ordered for that purpose.

Two cars of sandstone brought to the railroad by wagon have already been received from quarry at Cherokee, Ala., and five stonecutters began work June 28, 1895. Two and one-quarter cubic yards of arch stone was cut during June, 1895.

Cherokee Quarry, Alabama.—After using the supply of stone got out by contractor, the lock is to be built of sandstone from this point which has shown itself to be very suitable for the purpose. Quarry has been leased, right of way for 4,000 feet of switch track secured, switch surveyed, located, cross sectioned, and the grade made and ties cut and distributed. Rails will be on hand shortly after the close of the fiscal year. Great delay at this point was experienced by difficulty in securing proper railroad rates from the quarry to lock site, but the matter was at last equitably adjusted.

The necessary grading for tram tracks to be used in transferring stone from quarry to cable way has been done. Timber for three guy derricks has been got out, framed, and two derricks erected. Foundations for cableway towers and engines have been begun.

A well has been dug at the quarry, tool house and blacksmith shop erected, and stripping and quarrying already begun. All the derricks and loading overhead traveler will be in position by the end of August, 1895.

Following are detailed amounts:

Grubbing and clearing	acres..	5.76
Excavation, earth	cubic yards..	4,431
Excavation, loose rock	do....	37
Embankment	do....	5,324
Stripping	do....	2,802
Dimension stone quarried	do....	326
Grading for tracks	do....	1,187
Cross-ties made and delivered		2,230
Stone scabbled	cubic yards..	50
Derricks erected		2

Miscellaneous work included: Repairing wagon road; hauling stone from quarry to main railway; hauling machinery and material from railway to quarry (1 mile); making bolts and wedges; sharpening tools, etc.

5. FOOT OF BEE TREE SHOALS, ALABAMA, TO PADUCAH, KY. (225 MILES).

Information pertaining to the section of the river below Bee Tree Shoals (Riverton, Ala.) is very limited. In 1864–65 a reconnaissance of the Tennessee River from Paducah to Florence (225 miles) was made by a party of the United States Coast Survey, the data thus obtained to be for the use of the Mississippi squadron under the command of

Acting Rear-Admiral S. P. Lee, U. S. N. The "notes" pertaining to the map of the survey states that—

The stages of water in the Tennessee may be divided into low, ordinary, and high water. A low stage of water prevails under usual circumstances for three months of the year; a medium or ordinary stage lasts generally five months, and a high stage four months.

The average depth of the river at a low stage is, on all the bars, 3½ feet, excepting Duck River Shoals and Big Bend Shoals, on which 6 inches less is found at such a stage. This applies, however, only to the river below Chickasaw. The average depth at a medium stage may be considered 9 feet on the bars. At this stage only the Green Bottom Bar is bare.

Green Bottom Bar, Duck River Shoals, and Big Bend Shoals, above referred to, are distant 88 miles, 108 miles, and 199 miles, respectively, from mouth of river. Chickasaw settlement, 225 miles, is now known as Riverton, Ala. This section of the river has been heretofore covered by the estimates, surveys, and appropriations for the Tennessee River below Chattanooga, but no special allotments were made for the river below Bee Tree Shoals from the allotments for the Tennessee River made from the general appropriation acts of 1868 and 1869 or from the appropriations from 1870 to 1892, inclusive, aggregating the sum of $4,183,000.

A survey was completed in December, 1867, from Chattanooga to mouth of river, and an estimate of $40,000 submitted for removal of obstructions and construction of wing dams below Florence, 225 miles. (Report of Chief of Engineers, 1870, p. 389.)

Maj. Walter McFarland, Corps of Engineers, speaking of the lower Tennessee, in his report on lines of water communication between the Mississippi River and the Atlantic (Report of Chief of Engineers, 1872, p. 513), states that—

Descending the river we find that improvements of some kind or other, removing rock or gravel or constructing wing dams, in order to straighten or widen the channels or to give them sufficient depth, will be required at the following points, viz: Bear Creek Shoals, Indian Creek, Big Bend Shoals, Diamond Island, Wolf Island, Chalk Bluff, Beech Creek Shoals, Buffalo Shoals, Armstrongs Tow-head, bridge at Johnsonville, Duck River Shoals and Suck, Turkey Island Shoals, White Oak Island, Harrican Island, Leatherwood Shoals, Sandy Island, Panther Creek Island, McCulloughs Bar, Blood River Island, Pentecost Tow-head, Widow Reynolds Bar, Grubbs Tow-head, Little Chain, and Grand Chain.

In 1878 and 1879 some work was done at Duck River Shoals, 117 miles below Bee Tree Shoals. This shoal is a gravel bar, and is subject to considerable change from the action of the current. In 1881 and again in 1890 a small force with a snag boat was employed a short time in each year removing from the channel a large number of snags and overhanging trees. In 1882 the following localities below Rockport, about 4 miles below mouth of Duck River, were reported as requiring improvement: Duck River Suck, Johnsonville, Reynoldsburg Island, Turkey Island, Sandy Island, Little Chain, and Big Chain. It is stated in the Annual Report of the Chief of Engineers, 1892, page 1915, that—

During the last fifteen years the improvement of the river below Bee Tree Shoals, and in fact below Florence, has not received the attention its commerce and navigation appear to be justly entitled to, owing to the almost imperative necessity of concentrating all efforts and expending all money appropriated for the river "below Chattanooga" upon the removal of the main obstruction to navigation, the then impassable barrier of the Muscle Shoals. However, during that fifteen years a small amount of work was done, as above stated, below Riverton, foot of Bee Tree Shoals, Alabama.

In 1878 and 1879, in the channel at Duck River Shoals, amounting to	$7,304.95
In 1881 and 1882, snagging, etc	3,373.04
In 1890, snagging, etc	1,365.33
Total below Bee Tree Shoals from 1875 to 1891	12,043.32

For the above reasons stated and from information received from various sources, it is believed that the condition of the lower Tennessee demands an accurate survey. The Muscle Shoals Canal, opened to navigation November 10, 1890, and the work now in progress at Colbert Shoals and Bee Tree Shoals, make it very important that the lower Tennessee River, from the foot of Bee Tree Shoals to the mouth of the river, be put in such condition as to permit the safe passage at all seasons of any boats capable of navigating the Muscle Shoals Canal and the proposed Bee Tree and Colbert Shoals Canal now in course of construction. In order to accomplish this it will be necessary to have an instrumental survey made of this section as soon as possible, to obtain detailed maps of the obstructions, with a complete profile of the river, so that estimates can be made and project for the radical improvement of the river below Riverton, Ala., be submitted, based upon the necessary and definite data that can only be thus obtained.

If the Tennessee below Bee Tree Shoals is to be radically improved it is necessary, as above suggested, that an instrumental survey be made as soon as practicable, for the reason that the surveys, so called, heretofore have been rapid reconnaissances or examinations, and do not furnish the data necessary whereon to base an economic, advantageous, and energetic prosecution of any work of improvement that may be projected.

The act of Congress of August 17, 1894, in appropriating $100,000 for the improvement of the Tennessee River below Riverton, provided that of this sum "$90,000, or so much thereof as may be necessary, shall be used in the removal of snags and other obstructions to navigation between Riverton and the mouth of the Tennessee River, and the remainder of said sum of $100,000, or so much thereof as may be necessary, shall be used in making a survey of said Tennessee River below Riverton and submitting plans for its improvement."

REMOVAL OF OBSTRUCTIONS.

There being no snag boat belonging to the Tennessee River improvement, the steamer *H. D. Munson*, and the steam derrick boat *Alexander* were chartered on the 25th and 22d of October, 1894, respectively, for a period of sixty days, with the privilege of extension of time to four months longer if desired, the United States paying for the same $25 per day.

The necessary preliminary work being finished, operations were begun on November 5, and were continued until December 18, when a rise in the river made further work impossible. The boats were ordered to return to Paducah and were turned over to their owners at the expiration of the charters.

The following is a summary of the work accomplished:

Number of snags removed	159
Number of trees cut	47
Number of bowlders removed	5
Number of wrecked barges removed	3
Number of miles run	735

LIVINGSTON POINT, KENTUCKY.

The Annual Report of the Chief of Engineers, 1892, page 1916, describes Livingston Point as follows:

This is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee rivers, just above the mouth of the latter stream. This point and two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee flowing from a southern latitude and rarely if ever troubled by ice.

The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River is rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio has washed through at high water.

Allotments from the appropriations for improving Tennessee River below Chattanooga, to be used at Livingston Point, Kentucky, at the mouth of said river, have been made as follows:

Amount allotted:	
Act of September 19, 1890	$25,000
Act of July 13, 1892	25,000
Act of August 17, 1894	25,000
Total	75,000

A survey of Livingston Point was made in December, 1890, and based upon the data thus obtained a project for its preservation with an estimate of $180,000 was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of the same month.

As stated in Report of Chief of Engineers, 1891, page 2256—

The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush carried well down the bank below the water surface, supplemented by a pile and stone dike along the crest of the weakest portion of the line where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which from the present indications is likely to occur.

The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone in alternate layers. From low water to foot of dike broken stone will be carefully placed.

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1894, was $48,228.27, which has secured the completion of the dike on the Ohio side across the "wash-out" near the extremity of the point for a distance of 660 feet and the protection of the bank for a length of 2,330 feet, extending 632 feet above the dike and 1,038 feet below it, the average width being 47 feet, all the work being done on the bank facing the Ohio River, so as to protect at once the low part of the exposed strip or "point," which was in danger of washing away. The work under contract for the shore protection of the Ohio bank of Livingston Point by building a revetment of brush and stone riprap was carried on in December, 1892, and from April to September, 1893, 9,092 cubic yards of stone at $1.23 per cubic yard and 274 cords of brush at 94 cents per cord being used, at an aggregate cost of $8,979.90. This contract was completed and terminated November 9, 1893, in accordance with its terms.

During an examination of Livingston Point, in July, 1893, it was found that unusually heavy ice and high water had greatly injured the point by causing the wearing away of the Tennessee bank to an alarming extent; it was recommended that the Tennessee bank be also suitably protected by stone riprap; this work was approved and authorized to be done by hire of service and purchase of materials in open market. During the months of August and September, 1893, and January, 1894, 9,116.48 cubic yards of stone was placed as riprap protection to the Tennessee bank at a cost of $1.23 per cubic yard, $11,213.26.

Total amount expended, including outstanding indebtedness, during fiscal year 1894 was $23,804.68.

On the 21st of March, 1895, a letter was received from the city engineer of Paducah, Ky., in the name of the city council and others, reciting the danger of the wasting away of Livingston Point and the consequent destruction of the harbor of Paducah.

A few days later Assistant Engineer D. W. Church was sent to Livingston Point and reported in substance as follows:

The accompanying sketch, not made to scale, shows approximately the shore and channel lines of the Tennessee and Ohio rivers in the vicinity of Livingston Point.

At the time of the examination, March 25, 1895, the water was just high enough to flow over the point along the portion covered by the pile dike where the bank is the lowest, there being a slight current from the Ohio side.

Gauge at Paducah read 30.5.

The water was too high for a careful examination of the revetment work on Livingston Point, but it seemed apparent that there had been no cutting on the Tennessee side, as trees were standing erect in several places and some distance out from the high-water bank line, and the exposed portion of the revetment showed no evidence of caving or settlement.

On the Ohio side the revetment seemed to be intact and in good order, excepting at a point about 200 feet below the lower end of the dike, where there was a break about 50 feet long. It appeared as though there had been a settlement of the stone revetment, leaving an exposed bank, upon which the current and waves from an upstream wind were acting. A large eddy also aided in the process of erosion. The indications were that the cutting would be slight for some time and, as only temporary work could be done at the then prevailing stage of water, it seemed advisable to postpone repairing the break until a lower stage of water, when the whole work may be put in condition to resist the current at all stages.

Occasional examination was recommended to see whether the break is enlarged at the higher stages of the river.

The letter from the city engineer of Paducah above referred to was caused, however, by a matter quite distinct from Livingston Point.

There has been considerable erosion at the head of Tennessee Island at the point indicated on the sketch by the combined currents of the Tennessee and Ohio rivers. The chute behind the towhead is also filling up, and this, together with the cutting at the head of the island, leads to an apparently well-grounded fear that the Tennessee may form a complete junction with the Ohio at the head of the island and the combined streams flow past Paducah on the north side of Tennessee Island, transforming Paducah Harbor into a lake with entrance only at the lower end. This would be a serious calamity for steamboat interests in the neighborhood, as Paducah has always been famous as a safe winter harbor as well of importance to the navigation interests of the three great rivers.

The chute behind the towhead at Paducah is said to be entirely dry at an 8-foot stage on the Paducah gauge and is growing up with willows, these changes having become very marked in the last four years.

From the lower end of the towhead to a point about halfway up the chute are four extensive factories on the mainland whose interests are threatened by the filling up of this chute. Boats and tows can still reach these works at moderate stages, but only by ascending the chute from below. At high water these boats can pass in from above.

The city officials of Paducah are very desirous of having this closing chute dredged out, both in the interest of the manufactories now threatened with loss of river front and also to preserve their city harbor. It is thought that such dredging would cause a draw from the Tennessee River above, thereby taking a large part of the discharge of that river

down the Kentucky shore, and relieving the head of Tennessee Island from most of the impact now received from the Tennessee River.

In order to determine on the best plan for securing Livingston Point, studying results already attained and to be feared in future, a survey will be necessary at a comparatively low stage of water. This survey should extend from a point a short distance below Paducah to points far enough up both the Ohio and Tennessee rivers to determine the channel lines above Livingston Point and probable future changes in the two rivers likely to affect the Point, cross sections should be sounded at frequent intervals, and topography obtained below high-water bank lines. Such a survey could be made and worked up in ten days or two weeks (at a cost of $1,000 to $1,200) and need delay but slightly, if at all, work at the next low-water season.

Since March, 1895, nothing further has been done at this point.

Amount expended during the fiscal year, $5,711.64; balance on hand, $21,060.09.

Money statement.

July 1, 1894, balance unexpended	$421,697.09
Amount appropriated by act of August 17, 1894	400,000.00
	821,697.09
June 30, 1895, amount expended during fiscal year	134,959.55
July 1, 1895, balance unexpended	686,737.54
July 1, 1895, outstanding liabilities	24,763.19
July 1, 1895, balance available	661,974.35
Amount (estimated) required for completion of existing project, including Livingston Point, Kentucky	5,412,939.81
Amount that can be profitably expended in fiscal year ending June 30, 1897	2,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Cost of contract channel work at Ross Towhead, Tennessee River, July to November, 1894.

Excavation, solid rock, 1,852.58 cubic yards, at	$3.75
Excavation, gravel, 269 cubic yards, at	1.00

Cost of channel work in Tennessee River, Bridgeport Island, November, 1894.

Excavation, bowlders, 64 cubic yards, at	$4.16
Dredging, gravel and bowlders, 7,581 cubic yards, at	.35

Island Bar, Bridgeport Island.

Left chute:	
Excavation, solid rock, 889.7 cubic yards, at	$4.16
Excavation, gravel, 21 cubic yards, at	4.16
Right chute:	
Excavation, solid rock, 35 cubic yards, at	4.16
Trees cut, 390, at	.125

Beard Reef, below Guntersville.

Excavation, bowlders, about 20 cubic yards, at about	$10.00

Cost of dredging on Muscle Shoals Canal, Tennessee River, including labor, material, subsistence, 5 per cent interest on cost of plant, and 10 per cent depreciation.

Upper division, 13,075 cubic yards, at	$0.055
Lower division, 13,220 cubic yards, at	.072

Cost of dry rubble wall below Lock 4, Muscle Shoals Canal, Tennessee River, fiscal year 1894–95.

Quarrying, 69 cubic yards, at	$1.64
Wall building, 372 cubic yards, at	2.09
Previously quarried, 303 cubic yards, at	1.00
Total cost of this wall per cubic yard, at	3.215

Cost of quarrying for wing dam at Lock 9, Muscle Shoals Canal, Tennessee River, May 16 to June 30, 1895.

Stripping, 191 cubic yards, at	$0.448
Quarrying proper, 2,033 cubic yards, at	.458
Actual cost of stone as quarried, per cubic yard	.500

Cost of work at Cherokee Quarry, Alabama, for lock at Riverton, Ala., Tennessee River, February 1 to June 30, 1895.

Grubbing and clearing 5.75 acres, at	$70.73
Excavating earth, 4,431 cubic yards, at	.14½
Embankment, earth, 5,324 cubic yards, at	.137
Ties for tracks, 2,230, at	.16
Stripping, 2,802 cubic yards, at	.33
Quarrying dimension stone, 326 cubic yards, at	1.44
Scappling, 50 cubic yards, at	1.24

Cost of work done on lock at Riverton, Ala., Tennessee River, February 1 to June 30, 1895.

Excavating earth, 7,567 cubic yards, at	$0.17½
Excavating solid rock, 683 cubic yards, at	.97½
Embankment, earth, 2,489 cubic yards, at	.157
Ties for tracks, 2,101, at	.185
Cutting stone (arches), 2½ cubic yards, at	13.50

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, Tenn.

Articles.	Year ending December 31—			Articles.	Year ending December 31—		
	1892.	1893.	1894.		1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Grain	6,939	25,911	55,116	Live stock	226	528	1,089
Iron	13,365	11,988	14,567	Railroad ties		88	
Lumber	102	3,464	7,957	General merchandise	14,716	25,615	38,579
Sand	5,150	1,763	1,225	Cotton			14
Tan bark	412	800	27	Cotton seed	6		400
Flour	271	644	1,844				
Logs and wood	50,000	225	40,000	Total	91,187	71,026	160,818

Between Chattanooga, Tenn., and Decatur, Ala.

Articles	Year ending December 31—			Articles.	Year ending December 31—		
	1892.	1893.	1894.		1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Lumber	3,113	58,525	12,738	General merchandise	10,036	5,578	15,001
Cotton	3,038	190	4,095	Logs and wood	45,755	6,090	122,011
Live stock	621	197	921	Iron	2,250	4,581	6,664
Grain	7,396	1,798	7,559	Staves	5,272		
Flour	1,054	342	3,288				
Cotton seed	285	24	1,078	Total	78,820	77,325	173,355

Between Florence, Ala., and Paducah, Ky.

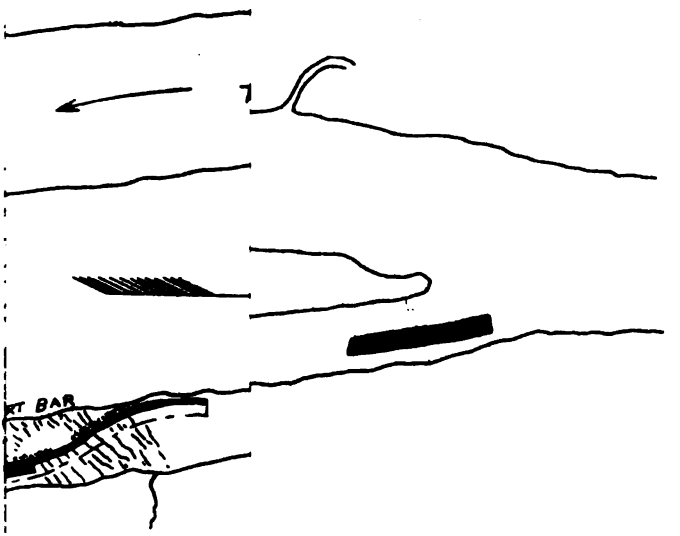
Articles.	Year ending December 31—			Articles.	Year ending December 31—		
	1892.	1893.	1894.		1892.	1893.	1891.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Iron	6,970	14,454	6,664	Flour	6,073	4,352	4,510
Staves	3,986	4,141	2,251	Cotton seed	995	24	1,078
Lumber	24,742	104,000	20,028	Sand	2,353	701	4,922
Cotton	6,105	1,837	4,437	General merchandise	36,114	28,177	22,089
Peanuts	4,649	2,029	640	Logs	71,336	30,300	192,012
Live stock	2,189	3,090	2,238	Railroad ties	46,749	139,203	37,175
Hoop poles	5,699	124	880				
Grain	18,249	12,121	9,990	Total	236,209	344,553	308,914

List of steamboats (stern-wheel) plying on Tennessee River above Chattanooga, Tenn., and its tributaries.

Name.	Length.	Breadth.	Depth.	Net tonnage.
	Feet.	*Feet.*	*Feet.*	
C. M. Fouche	93	14	2	61.12
Dayton	142	24.7	3.8	195.63
J. R. Hughes	98	17	3.5	95.15
J. C. Warner	142	31.6	4.6	201.05
J. W. Bussell	76	9	2.8	24.60
Lucille Borden	86	14	2.5	55.32
Oliver King	60	8	2.6	29.30
R. C. Gunter	153	28	4	337.30
Rockwood	130	25.6	4	150.52
R. T. Coles	118	24.6	4.2	134.91
Tallassee	60	12	2	22.16
Kingston	.....	11	3	37.80
Onega	.....	18	2.5	74.77
Ocoee	.....	12.5	1.6	19.18
Wyeth City	120	21.5	.....	138.96
Walter R. Love	112	18	3	80.14
Clinton B. Fisk	100	18	3.4	78.89
Key City	80	15	3.2	59.45
Maud	79	16.5	3.2	23.30
J. P. Kindrick	112	20	3.7	125.71
Ruth Dodd	37.5	7	2.8	11.12
Vollette	45	8	3	15.5
John A. Hart	41	7	2.1	5.63
Wm. Towle	90	16	3.5	63.86
E. P. Dawson	60	10	2.8	29.30
Telephone	93	19	2.6	97.47

List of steamboats (stern wheel) plying on the Tennessee River below Chattanooga, Tenn.

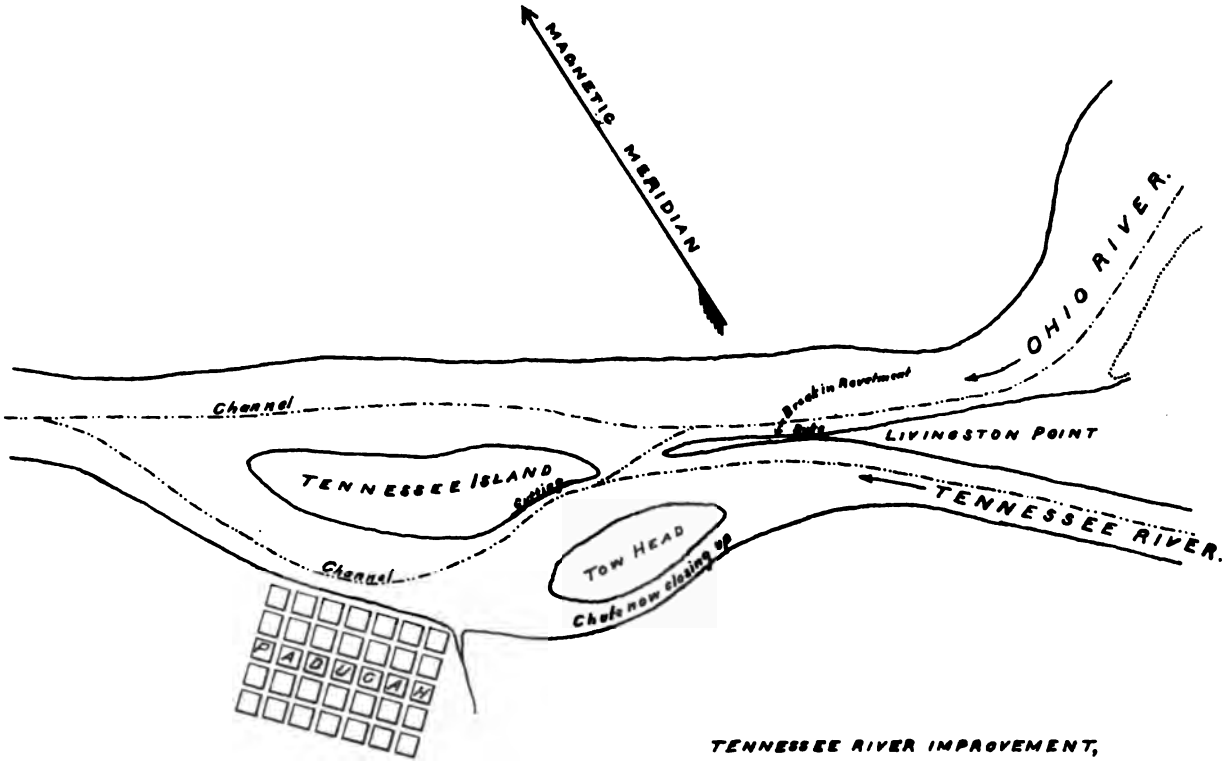
Name.	Length.	Breadth.	Depth.	Tonnage.
Between Chattanooga, Tenn., and Decatur, Ala.	*Feet.*	*Feet.*	*Feet.*	
Maude	.....	.....	2.5	23.03
B. F. Young	120	24	4	160.68
R. C. Gunter	153	28	4	337.30
Wyeth City	120	21.5	4.8	138.96
J. R. Hughes	98	17	3.5	95.15
Pinhook	94	18	3	90.60
R. T. Coles	118	24.5	4.5	134.91
City of Chattanooga	134	27.8	3.6	167.60
J. P. Kindrick	111	20	3.5	128.71
Rockwood	130	25.6	4	150.52
A. J. Duncan	150	32	4	460
Below Florence, Ala.				
City of Savannah	190	32	5	335.50
City of Sheffield	180	32	5.5	750
City of Paducah	183	37	5.25	700
W. S. Nesbit	212	36	6.5	680
Clyde	185	33	6	580
A. S. Willis	.....	.....	.....	133
Gus Genin	120	20	4	130



Annual Report June 30th 1895

Hugh A. Bingham

Captain of Engineers



TENNESSEE RIVER IMPROVEMENT,

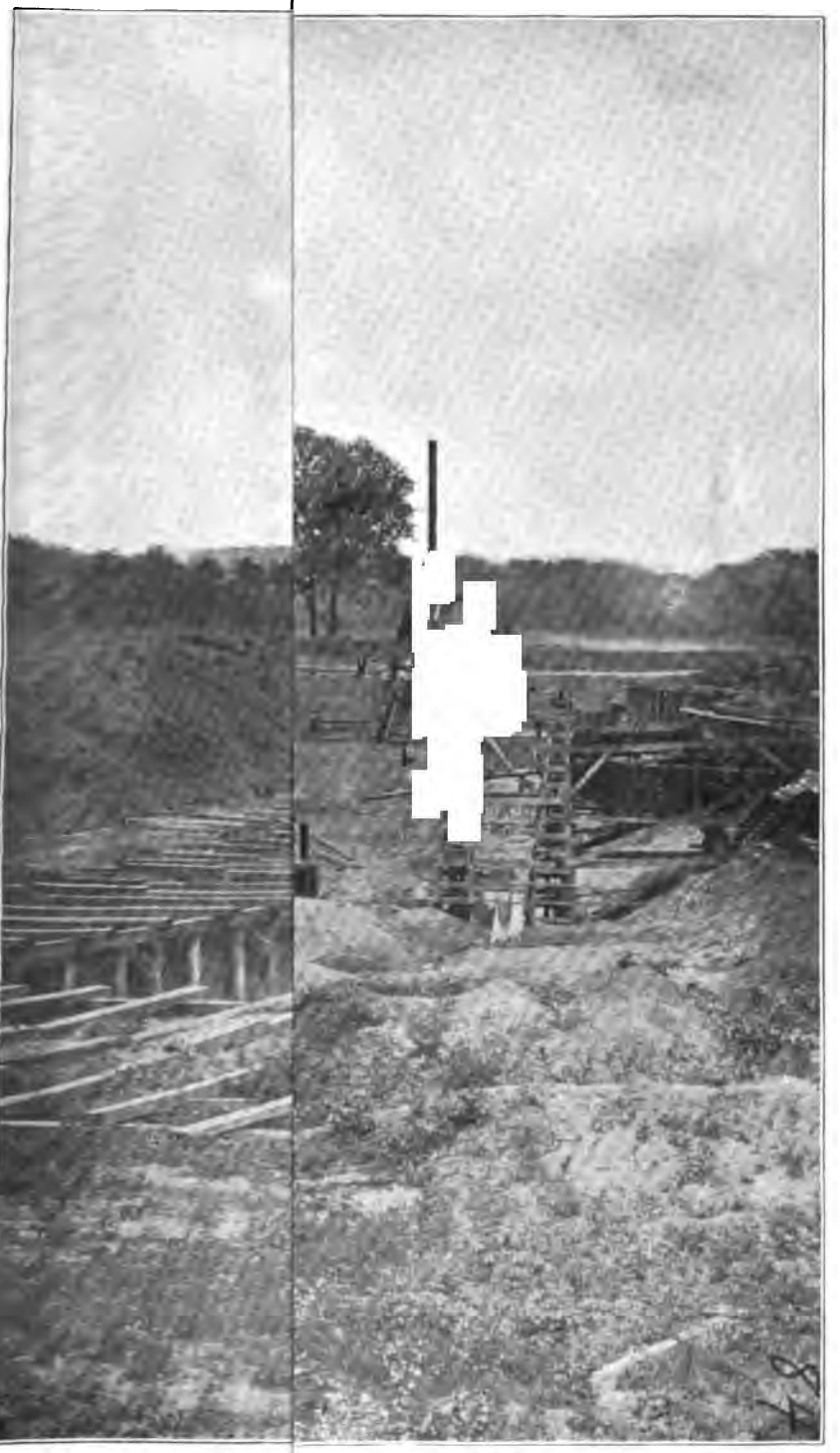
SKETCH IN VICINITY OF LIVINGSTON POINT.

MARCH 25TH 1895.

STAGE OF WATER, PADUCAH GAUGE 30.5.

SCALE 1 : 3000 = 1 inch

Eng 54 1



Photograph 1, taken May 17, 1895 out. On the left is seen the contractor's damaged temporary end (head) of lock pit.

Photograph 2, taken June 2

del 1 inch = 8 feet. Length of model about six feet. Lock lies

List of steamboats (stern wheel) plying on the Tennessee River, etc.—Continued.

Name.	Length.	Breadth.	Depth.	Tonnage.
Below Florence, Ala.—Continued.	*Feet.*	*Feet.*	*Feet.*	
C. Smith	132	29	3.5	350
City of Chattanooga	134	27.8	3.6	167.60
J. P. Kindrick	111	20	3.5	128.71
Edwin Wood				
I. N. Hook	110	19.2	3	55.95
Dick Clyde	96	17.4	3.9	76.84
R. A. Speed	124	22	4.2	140.57
Al Martin	112	23.6	4	96.68
Maggie Belle	95.6	18.4	3.6	52.81
Rockwood	130	25.6	4	150.52
A. J. Duncan	150	32	4	460
B. F. Young	120	24	4	160.68
R. C. Gunter	153	28	4	337.30
Wyeth City	120	21.5	4.8	138.96
R. T. Coles	118	24.5	4.5	134.91
Sentinel	83.6	17.6	3.25	35.96
Allen J. Duncan	149	31	4	318.46
Wyandot	91	18	3	65.94
Corinne	46.5	8.4	4.6	13.39
Annie Barnes	53	12	3	9.16
Frank Burnett	50.6	9.2	2.8	7.61
Clayton H. Webb	112.9	24.7	3	98.7
Mary N	69	14	3	36.54
Wm. Towle		16	3.5	63.86
Montezuma	49	12	3.5	16.19
Lamasco	85	15	3	37.73
Kenton	106.2	33	5.2	153.08

B B 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal, which had been in course of construction since 1875, was formally opened to public traffic November 10, 1890.

The canal consists of two sections, known as the Elk River Division and the Muscle Shoals Division, being named thus from the shoals of the same names on the Tennessee River around which the two sections were constructed.

The Elk River Division is 1.5 miles long, not less than 100 feet wide, and has two locks, known as Locks A and B, each 60 by 300 feet, with a total lift of 23 feet.

The Muscle Shoals Division, beginning about 8 miles below Lock B, is 14.5 miles long, from 70 to 100 feet wide, and has been constructed by rebuilding and enlarging the old canal built by the State of Alabama, 1831–1836. This old canal was used for one season, but the obstructions in the river above and below limited navigation to certain stages of the water; hence it was operated for one year only, after which, no funds being appropriated for its maintenance, it was disused and fell into decay.

The lower division of the canal contains nine locks of the same dimensions as those in the upper division, viz, 60 feet wide and 300 feet long, with a total lift of 85 feet.

During the past fiscal year the canal was kept in working order and no delay in traffic occurred. On the contrary, the towboat has been able several times to assist boats in trouble in the vicinity.

The locks, buildings, and grounds were cared for and kept in good condition; the entire line of embankment was patrolled daily for the purpose of detecting leaks, a large number of which were closed with broken stone, gravel, and clay, although no serious break occurred.

Work done during the year was as follows:

Upper Division (Elk River).—This division consists of an upper pool formed by a rock-fill dam extending from the lower end of Brown Island to Lock A, a mile of canal trunk between Locks A and B, and a dredged channel below Lock B extending to channel in Gilchrist Chute. Total length, about 5 miles.

The hydraulic machinery at Lock A was cared for and kept in as good condition as practicable, which requires ceaseless watching and repairs, as the whole system is in need of thorough overhauling. Leaky pipes and cocks were repaired and the gate-engine castings, which are cracked, were patched several times.

Large numbers of logs and quantities of drift were cleared from the channel above Lock A and passed through into the river by means of the drift sluice provided for the purpose.

Between Locks A and B weeds and brush were kept cut on right of way and embankments were cared for.

In August, 1894, a leak which had existed for some time between the stone miter sill and the cushion timbers at the lower end of Lock B became so much worse as to interfere seriously with the working of the lock. Examination showed that the ends of the cushion timbers nearest the lock walls were rising, owing to slip of the anchor bolts. As a temporary expedient, until stage of water should permit emptying of lock chamber, the cushion timbers were driven back into place and held there by 6 by 12 inch pine timbers bolted vertically against the lock walls with their lower ends abutting against the cushion timbers. September 24, 1894, a timber and canvass cofferdam was thrown across between the lower wing walls of the lock and the water pumped out. The dam proved quite tight, though some difficulty was at first experienced in making a joint between it and the rough quarry-face masonry of the wing walls; but owing to leakage from the upper lock and the discharge into the upper pool of a small stream which could not be diverted it was found necessary to use a 6 inch and a 9-inch centrifugal pump almost continuously.

On examining the cushion timbers it was found that four of the 6-foot hollow anchor bolts near the north end were quite loose and could be lifted out easily. These bolts are in the form of a pipe, threaded for a nut at the upper end and split at the lower end into four parts by longitudinal slits about 2 feet long. They fit loosely into holes drilled in the stone sill and are fastened in place by iron wedges dropped to the bottom through the bore of the bolt and driven by a follower and sledge. These wedges are intended to spread the split ends of the bolts, and if properly seated hold well. But, from the loose bolts taken out, it was found that wedges had jammed in the middle of the bolt instead of going to the bottom, and consequently had had little or no spreading effect. The wedges were removed and the bolts properly replaced. Holes were then bored at several points along the cushion timbers, and neat cement grout used to fill the interstices between timber and stone.

While this work was in progress the old wooden lift valves were removed from the filling and emptying culverts and replaced by new cast-iron valves, hung on a vertical shaft placed near the center and maneuvered by a double-geared winch on the lock coping. These valves are of the same pattern as those previously placed at all locks on the lower division and reported on in Annual Report of Chief of Engineers, 1894, page 1825.

The canvas dam used was placed in ten hours and removed in five; its length was 60 feet. Head of water, 6 feet. Total time occpuied in above-described work, sixteen days.

During the month of June, 1895, there were dredged from—

	Cubic yards.
Channel above Lock A, mud	12,500
Channel below Lock B, clay and gravel	575
Chamber, Lock B, loose rock	40

Lower division (*Muscle Shoals*).—This division consists of an upper pool half a mile long, formed by extension of canal embankment above Lock 1, and of eight intermediate pools and nine locks, numbered from 1 to 9, beginning at the upper end. Total length, 14.5 miles. Total lift, 85 feet. Maximum single lift, 13 feet at Lock 6. Size of locks, 300 feet long between hollow quoins by 60 feet clear width.

A canal railway extending the whole length of this division is used in towing barges and in general work of maintenance.

Dredging during the year ending June 30, 1895.

	Cubic yards.
Section 0 (upper entrance) deepening, mud	1,600
Section 1, deepening, mud	200
Section 3, deepening, mud	300
Section 4, widening and deepening, mud and clay	5,950
Section 16, widening and deepening, mud and clay	5,050
Section 26, deepening, gravel	15
Section 31, deepening lower entrance, gravel	120
Total	13,235

The dredge is of the Bucyrus elevator type, having a chain of 24 buckets, each of 5 cubic feet capacity. In July it was laid up for repairs, thoroughly overhauled, and completed by November. Actual time occupied in dredging was three months. Under favorable conditions it has dredged 1,800 cubic yards in eight hours. While the dredge was laid up, when it was not being repaired, the crew was employed on repair or construction work along the canal.

A large amount of repair and construction work was done at the canal shops near Lock 6 during the year, of which the principal items are as follows:

Machine and blacksmith shop.—Air chamber made for boiler feed pump of steamer *Colbert;* engine cylinders drilled and tapped for indicators; new stirrups made for hog-chain braces and hog chain lengthened; small vertical boiler overhauled, repaired, and mounted on main deck as auxiliary.

Bucyrus dredge dismantled, eyes in cast-steel links and buckets bored and bushed with steel; cast-iron rollers for bucket chain bored, turned, and new shafts made for same; steel steady pins made for holding main link pins; knuckle timber of hull sheathed with three-eighths-inch sheet steel to prevent abrasion in towing along canal; 15 brass lubricating pistons turned for bucket and link connections; machinery reassembled and dredge put in working order.

In connection with this work a small overhead traveling crane of 2 tons capacity was built in the machine shop to facilitate handling heavy buckets, links, rollers, and other heavy machinery.

Miscellaneous repairs were made to wicket valves and maneuvering gears at the severel locks.

The small portable engine used with centrifugal pumps was thoroughly overhauled; new piston rod and rings, steam-chest cover and bolts, cylinder-head bolts, and valve stem made.

An old bolt-cutting machine was repaired and put up in the machine shop.

The boiler feed pump of steamer *McPherson* was repaired.

A 15-inch turbine was installed and connections made to two 9 by 9-inch Clayton air compressors. The compressors were installed on masonry foundation in the power house. Line shaft was hung and 800 feet of wrought-iron 2½-inch pipe laid to connect compressors with shops. These compressors are used for power in the shops and also to furnish blast for the forges.

An old steam pump was rebuilt for use as boiler feed pump on dredge tender.

Pump-rod brasses were made for steamer *S. H. Long.*

The gate-maneuvering spars at Locks 1 and 2, which had become bent, were straightened.

Fifty linear feet of 2-inch steel shafting was turned and hung to transmit power from machine shop to carpenter shop.

All the iron and steel work was made for a universal woodworker and a jig saw in carpenter shop.

Broken gate-maneuvering gear castings were repaired for Locks 2, 4, and 5.

Hand railings on drop gates at Locks 2, 6, and 7 were rebuilt.

Four switch rods and frogs were made for canal railway.

A Crosby gauge tester was made for testing steam gauges.

A map-lettering press was completed; new racks put on drop-gate spars at Lock 5; pump valve and one brass stud bolt made for steamer *Colbert;* truss rod on flat car repaired; work begun on traveling crane for storage building; brass-melting furnace completed; ironwork made for wood-turning lathe; headlight for locomotive repaired; crucible tongs made; ironwork for blue-print apparatus made; capstan of steamer *Colbert* repaired and new steel rollers made; base plate of miter gate capstan at Lock 6 repaired.

Tools and machinery repaired and kept in good condition throughout the year.

Carpenter shop.—A new frame building, 30 by 48 feet, for storage of property was built complete, excepting main doors and part of flooring.

One 8-wheel inspection car for railway, 28 by 8 feet; two 8-wheel flat cars, 25 by 8 feet, were built complete.

New drop-gate maneuvering spars were made and put in place at Locks 6 and 8.

The dredge was dry docked on timber cribs in Lock 6, and 100 linear feet of damaged knuckle timber was removed and replaced by new; part of the bottom adjacent to knuckle timber was also rebuilt.

Two hundred and sixty-five linear feet of pine sheathing was placed on the vertical face of the masonry dry wall below Lock 9, as a protection to boats entering the lock.

Timber covers were made for large double valve gears at Locks 3 and 4.

Vertical timber frame was made for the 9-inch centrifugal pump.

Six wooden belt pulleys were made for machine shop.

Six skylights were put in the machine shop and one in boiler room.

One 60-foot barge was redecked.

A new lumber shed was built.

Woodwork of universal woodworker and of jig saw was constructed and these two machines built and put in use.

Twelve small flat cars were repaired.

Two new hogchain braces were made and put on steamer *Colbert;* stiffening braces were put in the hull; four large deck cavils made and placed; bulkhead built around boiler on main deck.

A small derrick was made and erected at Lock 1 for removing logs and drift.

Boathouse, 16 by 24 feet, for skiffs was built.

Small frame building was erected for storage of oil.

Lock-gate runways and spar platforms were rebuilt at Locks 1, 3, 4, 5, 6, 7, and 8.

Two survey quarter boats were repaired.

New timber slide valve was made for use in dam below Lock 4.

New sluice valve made and placed in Helltown Dam; lock-gate walk ways rebuilt at Locks 8 and 9; floor of storage building completed; new floor laid in watchman's house at Lock 8; new stiff leg made for large derrick at Brook's quarry; four ladders made; railroad volocipede rebuilt; 9-foot extension made to carpenter shop to give floor and space for lathe; blue-print frame made; room for paint shop floored and ceiled; main deck on steamer *Colbert* repaired and two lockers made; capstan repaired and line reel made; two hatch covers made; pilot house raised; draft marks put on hull and pantry repaired.

Painting.—Watchmen's houses at Locks 1 and 4 were repainted; names painted on steamer *Colbert.*

In addition to the above very many minor repairs were made to locks, buildings, boats, cars, locomotives, machinery, and tools.

Stonework.—Six cubic yards of cement masonry was laid as foundation for air compressors.

Three hundred and twenty-eight linear feet of open stone drain was laid for surface water on United States land north of Lock 6.

Forty-three cubic yards of rubble retaining wall was built at Locks 5, 6, 7, and 8.

One hundred and nine cubic yards of stone was quarried and 75 cubic yards cut for abutments at entrance of dry dock at Lock 6. Fifty-five cubic yards of sand was hauled for the masonry.

Retaining wall below Lock 4.—The old face wall at this point having fallen, which was intended to prevent wash of railway embankment by water-discharge culverts of the lock, the building of a solid retaining wall of dry masonry was begun. Three derricks were erected in December, 1894. The wall as proposed will be 200 feet long, 14 feet high, 6 to 7 feet thick at base, 3 feet thick at top, with batter of 3 inches per foot. The size of stone used varies from 2 to 21 cubic feet. Work was interrupted in December and January and resumed again in May. Up to June 30, 1895, 451 cubic yards of earth and old masonry has been excavated, and 342 cubic yards of stone laid. Five hundred and sixteen cubic yards of earth was filled in behind the wall, and this work is now practically complete.

Miscellaneous.—About 1,000 linear feet of ditch, with average cross section of 12 square feet, was dug to drain the swampy bottom land belonging to the United States south and west of Lock 6. The excavated material was used to fill adjacent sloughs.

A large number of unimportant leaks through the canal embankments were closed by gravel and clay.

One thousand eight hundred and fifty-six cubic yards of earth was used in strengthening and grading embankments at various points along the canal.

One mile of road between the United States land at Lock 6 and the public road was kept in repair.

The section gang was employed in care of railway.

Locomotives were employed in towing and miscellaneous hauling.

Locks, buildings, and grounds have been cared for and kept in good condition.

Steamer *Colbert* was engaged in carrying freight, towing coal, etc. The assistant engineer in charge of canal superintendence, Mr. W. A. McFarland, M. E., has been alert, efficient, and loyal.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
July 1, 1892	45,232.90
July 1, 1893	60,975.19
July 1, 1894	63,772.63
Total	241,772.76

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation (indefinite), to be applied to current expenses in operating the Muscle Shoals Canal, from July 1, 1894, to June 30, 1895.

Amount required for fiscal year ending June 30, 1896	$65,000.00
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities	206.89
Additional allotment required for fiscal year ending June 30, 1895	64,793.11

To be expended as follows:

1 assistant engineer, at $200 per month	$2,400
1 master mechanic, at $100 per month	1,200
1 overseer, at $100 per month	1,200
1 clerk, at $100 per month	1,200
11 lock masters, at $75 per month each	9,900
11 assistant lock masters, at $40 per month each	5,280
1 locomotive engineer, at $60 per month	720
1 engineer at machine shop, at $60 per month	720
1 telephone lineman, at $50 per month	600
2 blacksmiths, at $75 per month each	1,800
1 carpenter, at $80 per month	960
1 overseer, at $80 per month	960
30 laborers, at $30 per month each	10,800
Dredging and towboat crews, $800 per month	9,600
Subsistence, $525 per month	6,300
Repairs of dredge, plant, material, and contingencies	11,360
Total for year	65,000

Detailed expenses incurred for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1895.

Month.	Office and administration.			Operating, care, repairs, etc., Locks A and B.			
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.
1894.							
July	$250.00	.....	$250.00	$410.00	$61.26	$23.84	$495.10
August	275.00	.....	275.00	410.00	59.08	17.24	486.32
September	290.00	.....	290.00	410.00	33.35	43.00	486.35
October	275.00	.....	275.00	426.50	114.35	21.39	562.24
November	275.00	$21.00	296.00	410.00	45.10	16.76	471.86
December	260.00	.....	260.00	410.00	37.95	15.40	463.35
1895.							
January	275.00	.....	275.00	410.00	48.38	5.87	464.25
February	275.00	.....	275.00	410.00	34.74	63.08	507.82
March	275.00	3.75	278.75	410.00	52.45	17.95	480.40
April	275.00	7.80	282.80	410.00	50.75	19.26	480.01
May	275.00	10.40	285.40	410.00	107.27	93.17	610.44
June	275.00	.....	275.00	410.00	115.17	32.16	557.33
Total	3,275.00	42.95	3,317.95	4,936.50	759.85	369.12	6,065.47

Detailed expenses incurred for operating and care of Muscle Shoals Canal, etc.—Cont'd.

Month.	Operating, care, repairs, etc., Locks 1 to 9.				Grand total.
	Labor.	Subsistence.	Supplies.	Total.	
1894.					
July	$2,717.20	$365.07	$691.36	$3,773.63	$4,518.73
August	2,586.67	358.67	499.99	3,445.33	4,206.65
September	2,853.09	180.31	1,247.82	4,281.22	5,057.57
October	2,870.31	690.27	620.60	4,181.18	5,018.42
November	2,733.28	267.30	486.20	3,486.78	4,254.64
December	2,685.24	221.87	446.84	3,353.95	4,077.30
1895.					
January	2,769.70	291.54	171.85	3,233.09	3,972.34
February	2,862.77	255.96	1,829.34	4,948.07	5,730.89
March	3,033.55	277.04	520.65	3,831.24	4,590.39
April	3,291.61	301.03	558.54	4,151.18	4,913.99
May	3,901.10	573.18	3,792.93	8,267.21	6,163.05
June	4,361.35	476.19	3,619.27	8,456.81	9,289.14
Total	36,665.87	4,258.43	14,485.39	55,409.69	64,793.11

Statement of traffic through the Muscle Shoals Canal during the calendar year ending December 31, 1894, compared with traffic during years ending December 31, 1891, 1892, and 1893.

	Year ending December 31—			
	1891.	1892.	1893.	1894.
Steamers.....number..	24	60	95	37
Barges.....do....	19	55	69	30
Rafts.....do....	6	5	9	27
Miscellaneous craft.....do....	9	12	35	40
Tonnage.....tons..	2,420	4,476	12,812	5,891
Lumber.....do....	633	962	3,543	3,127
Cotton.....do....	62	255	59	.....
Grain.....do....	840	404	280	62
Flour.....do....	54	11	591	141
Oak extract.....do....	600	800	.....	.....
General merchandise.....do....	47	2,119	3,110	1,201
Logs.....do....	225	471	9,049	19,522
Iron.....do....	520	610	.....	.....
Coal.....do....	150	150	4	295
Total	3,131	5,782	16,636	24,348
Passengers.....number..	171	936	3,506	566

The above is exclusive of supplies carried by Government steamers.

During the last six months of the year when traffic should be heaviest, steamboat traffic was almost suspended in consequence of extremely low water.

Number of lockages, 1,257.

B B 3.

IMPROVEMENT OF HIWASSEE RIVER, TENNESSEE.

The Hiwassee River rises in the Blue Ridge Mountains in western North Carolina and northern Georgia, and flowing in a west-northwesterly direction enters the Tennessee River about 35 miles above Chattanooga and 148 miles below Knoxville. After breaking through the Smoky Mountain range and receiving the waters of the Ocoee, near Columbus, the Hiwassee becomes a stream of good capacity for navigation.

As early as 1830 the State of Tennessee made some minor improvements, but the work was only of temporary advantage. The act of

Congress of June 23, 1874, authorized an examination of this river. The examination was made in September, 1874, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Report of Chief of Engineers, 1875, pp. 809–813.) The principal obstructions were found to be rock reefs, gravel bars, snags, and overhanging trees, and are of the same general character as those of the upper Tennessee, and the regimen of the river is equally permanent.

The project for the improvement was based on this examination, and consisted in narrowing the waterway by wing dams at the shoal places and excavating rock reefs and gravel bars, so as to secure a navigable channel 40 feet wide and 2 feet deep at ordinary low water to Savannah Ford, about 43 miles from mouth of the river.

The original estimate submitted in 1875 was increased, from 1878 to 1884, inclusive, to $36,500, which amount has been covered by the ten appropriations made for this improvement, viz:

Act of—		Act of—	
August 14, 1876	$10,000	July 5, 1884	$2,500
June 13, 1878	10,000	August 5, 1886	2,500
March 3, 1879	3,000	August 11, 1888	1,000
June 14, 1880	3,000	September 19, 1890	1,500
March 3, 1881	1,500		
August 2, 1882	1,500	Total	36,500

No appropriation has since been made.

The amount expended to June 30, 1894, including outstanding indebtedness, was $36,404.03.

The Annual Reports for 1892 and 1893 state that—

> The work has resulted in a partial improvement of the lower river, securing an increased depth of channel and the removal of surface obstructions and overhanging trees.
>
> The work was done at different times at the following obstructions: Matthew Shoals, McElrath Shoals, Sivils Shoals, Magills Islands, Blackbird Shoals, Graves Ferry and Shoals, Canefield Reef, Lasters Creek Shoals, Brindley Shoals, Denton Island Shoals, Boyd Shoals, Horseford Shoals, and Gamble Shoals. The Hiwassee is now navigable for steamboats from its mouth to Charleston, 21 miles, during the boating season on the upper Tennessee River. Above Charleston to Savannah Ford flatboats are used for transportation.

The work was first begun in June, 1877, at Matthew Shoals, and at intervals since, as each appropriation became available, efforts have been made to improve the channel at this the principal obstruction to navigation.

In order to distribute the fall at these shoals a part of the main dam extending from the right bank, opposite the lower island, was removed, and a new spur dam, 167 feet long, built on a reef extending from the north bank, was constructed to back up the water. The effect has been very satisfactory to the extent of securing a reduction of the current's velocity opposite the lower island, but owing to high water and the exhaustion of the appropriation it was not practicable to complete the work. The other dams were straightened, raised, or strengthened where necessary; the banks also were protected by felling trees and placing brush in position, anchoring the same with stone; this resulted as desired in protecting the bank and deflecting the current to the opposite side of the river. A ringbolt was securely placed in position on end of lower dam to assist heavily laden ascending boats.

Work was suspended in September, 1892, the funds available for active operations being then exhausted.

Boats belonging to the Tennessee Transportation Company ply upon this stream during the season of navigation. Small boats of about 100

tons capacity can navigate the Hiwassee River about eight months in the year.

The estimates of cost of improving the Hiwassee River have been appropriated and expended. If it be determined to do further work upon this stream, it would be advisable that an instrumental survey be made to obtain accurate data whereon to base a project and estimate for the radical improvement from its mouth to Savannah Ford. This stream, in common with other mountain streams of this section, requires that the channel be kept clear of snags, logs, etc., brought down by the annual floods, and it is advisable that provision be made for such work, so that the advantages resulting from previous expenditures can be maintained.

No work was done on the existing project during the fiscal year 1894–95. No survey of this river has ever been made. The largest part of the commerce to Chattanooga from the upper Tennessee River comes out of the Hiwassee.

There were no expenditures during the fiscal year.

Money statement.

July 1, 1894, balance unexpended	$72.93
July 1, 1895, balance unexpended	72.93
July 1, 1895, outstanding liabilities	23.04
July 1, 1895, balance available	49.89

COMMERCIAL STATISTICS OF HIWASSEE RIVER, TENNESSEE.

Articles.	Year ending December 31—		
	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*
Grain	1,467	1,292	6,121
Tan bark	320	275	.....
Live stock	165	65	188
Lumber	6,052	55	13
Flour	80	31	59
Sand	338	6	362
General merchandise	1,707	4,968	2,682
Cotton	.....	.....	14
Cotton seed	.....	.....	400
Total	10,129	6,692	9,839

List of steamboats (stern-wheel) plying on Hiwassee River.

	Length.	Breadth.	Depth.	Net tonnage.
	Feet.	*Feet.*	*Feet.*	
R. T. Coles	118	24.6	4.2	134.91
Ocoee	.....	12.5	1.6	19.18
J. P. Kendrick	111	20	3.5	128.71

B B 4.

IMPROVEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

The French Broad River is one of the largest tributaries of the Tennessee. This stream has its source in North Carolina, on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock,

and after a course of 121 miles unites with the Holston River 4½ miles above Knoxville, thus forming the Tennessee River.

An appropriation was made by the State of Tennessee about 1840 for the purpose of improving the rivers of the section then known as the "East Tennessee district," and the improvement of Seven Islands Shoals of the French Broad River, about 30 miles below Dandridge, was begun under direction of commissioners appointed by that State. The State of Tennessee also built some dams above Dandridge, but these, with the exception of a few repaired by the United States in 1881, have been removed during the progress of the work under the present project.

An examination was made of the French Broad in Tennessee under authority of act of Congress, July 11, 1870, and the report upon it is to be found in the Report of Chief of Engineers for 1871, pages 491–494. A reexamination in Tennessee was ordered by Congress in act of March 3, 1875, "from its junction with the Holston, at Knoxville, to Leadvale, Tenn." The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale, mouth of Nolachucky River, a distance of 90 miles, the river is impeded by the surface obstructions usually found in mountain streams. This stretch of river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge, about 50 miles. The fall being only about 1 foot per mile, the channel can be easily improved. From the junction of the Nolachucky River to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slack-water navigation, the fall being 7 feet per mile.

The present project of improving the channel from mouth of river to Leadvale, about 90 miles, consists in removing surface obstructions, cutting down overhanging trees, and building wing dams where necessary, so as to permit the passage of boats drawing 2½ feet during the ordinary low-water season. Under this plan operations have been carried on at the most serious obstructions.

The following appropriations have been made by Congress for improving French Broad River in Tennessee, viz:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$10,000
March 3, 1881	3,500	July 13, 1892	15,000
August 2, 1882	5,000	August 14, 1894	7,000
July 5, 1884	3,500		
August 5, 1886	6,000	Total	70,000
August 11, 1888	10,000		

The total amount expended at the close of the fiscal year ending June 30, 1894, including outstanding indebtedness, was $63,523.86. This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish traps, constructing and modifying wing dams, and revetting the banks when necessary. A list of these ten obstructions, with their distances below Dandridge and the work done at each to June 30, 1890, is given in the Annual Report of the Chief of Engineers, 1891, pages 2262, 2263.

The improvements made at Seven Island Shoals during 1889 and 1890 are therein reported as the most important effected on the French Broad River in several years, and have resulted in making this obstruction navigable for steamers at stages of the river when upstream navigation was heretofore impracticable. The work at these shoals, although not completed, has done much good. Before any work was done here

by the United States it usually took a steamboat from one to one and a half days to go through, but now the passage can be made in forty-five minutes. At Bryant Shoal the modification and enlargement of the old wing dam and the removal of bowlders from the channel has greatly improved navigation. Great benefit has resulted from the improvement made at Jumping Moses Shoal, near mouth of the river, its dangerous condition having been greatly modified.

During the fiscal years 1891 and 1892 the improvements were continued at Bryant Shoals and Hanging Rock Shoals. The bar at the foot of Bryant Shoals was excavated and two dams constructed, running out from the north bank. The old dam, extending from the foot of McCroskey Island, was straightened and made parallel to the main current, then lengthened to hold water upon the shoal. Across the island chute, about 500 feet below the mouth of Pigeon River, a cut-off dam was built, submerging the bar complained of as shutting off all navigation during low water, through which the current will soon cut a good chute sufficient for the passage of boats. At Hanging Rock Shoals the channel was changed from the north to the south side of Brabson Island. The new channel was cleared of snags, drifts, etc., and some rock excavated. Eight dams were built, a retaining dam at foot of island, with two spurs jutting toward the new channel to divide the fall and guard against the formation of a bar near the foot of the main dam; the old dam on the south bank of the island was utilized and 185 feet added to it in the direction of the new channel; two dams were built out from the south shore of Brabson Island and two dams across the head of the chute, closing the old channel, which was left open as long as possible, and no detention of boats resulted from the change.

A small light-draft steamer, *Stephen H. Long*, was built at Chattanooga, Tenn., for use upon the upper Tennessee and its tributaries, and was paid for from the proceeds of the sale of the U. S. S. *McPherson*, to the works on the lower Tennessee River.

Work was in progress at the Hanging Rock Shoals at the beginning of the fiscal year ending June 30, 1894, and was continued at several obstructions until January 1, 1894, when operations were suspended, the funds available for channel work being nearly exhausted. The fleet, with other engineer property, was dropped down to winter moorings at Chattanooga, Tenn., as a measure of economy and safety.

Work was carried on during 1893–1894 at Hanging Rock Shoals, Denton Shoals, Nichols Reef, and Zimmerman Ford, and examinations and maps were made of the obstructions at Evans Island, Saffels Shoals, Hanging Rock Shoals, Cement Shoals, Campbells Shoals, and Pennyroyal Shoals. The work done appears to give satisfaction.

The improvement of the French Broad River, Tennessee, is of importance to the inhabitants along its banks, not only by reason of its increasing commerce, but because of its being constantly used as a highway for travel by the people themselves, a large number of passengers being carried by the small steamers that ply upon this stream. The commerce consists principally of marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise. The completion of the existing project of improvement will materially aid in the development of the mines, and will open a river highway for the transportation of the mineral wealth of the mountains and the products of the rich agricultural lands of the region drained by the river and its tributaries.

As soon as the spring of 1895 opened, after the necessary repairs had been made to the one fleet, which is used in succession for work on all the upper tributaries of the Tennessee River (including the building of

a drilling raft), it was moved to the vicinity of Dandridge, Tenn., and the work of inspecting and repairing the various dams began. This will be carried on downstream, and will be completed by the time the Tennessee River is at a low enough stage to resume work there.

An important dam at Hanging Rock had been broken by ice during the winter of 1894-95 and was found to have a gap 80 feet long and 6 feet deep. This was repaired in June, 1895, a tripod dam being used to deflect and break the force of the current. One thousand four hundred and sixty-five cubic yards of stone was used, at a cost of $1.45 per cubic yard in the finished dams, including cost of quarrying. The longitudinal dam at the foot of the shoal was extended 270 feet, the cost being the same as above given.

The fleet was then moved to Evans Island and work was begun on bank protection necessary at Zimmermans Ford.

The amount expended during the fiscal year, including outstanding indebtedness, was $1,927.78.

The balance ($4,433.55) of the appropriation of August 17, 1894, can be advantageously expended in repairing old work and keeping channel clear under project already approved.

The estimate of $150,000 for improving the French Broad River from its mouth to Leadvale is insufficient to secure the 2-foot ordinary low-water navigation sought to be obtained under the project. The examinations heretofore made of the French Broad River were limited and incomplete, and are not sufficient whereon to base a revision of the estimate of 1871. If a radical improvement of the channel is to be undertaken, it is recommended that a detailed survey be made to obtain the data necessary to determine the cost of the work as projected, having in view its advantageous and economical prosecution.

LITTLE PIGEON RIVER, TENNESSEE.

This stream is formed by the junction of its east and south forks at Sevierville, Tenn., and flowing northwesterly for about 5 miles, it enters the French Broad River about 32 miles above Knoxville.

An examination of Little Pigeon River was made under the provisions of river and harbor act of September 19, 1890. The channel was found to be obstructed by rock reefs and gravel shoals, the object of the proposed improvement at the estimate of cost submitted ($10,000) being to open up the river to navigation as far as Catlettsburg, about 2 miles, permitting the passage of the small steamers that ply upon the French Broad River, and occasionally during extreme high water to ascend to Sevierville, 5 miles from the mouth of the river. (See Report printed as House Ex. Doc. No. 159, Fifty-first Congress, second session, and Report of Chief of Engineers, 1891, pp. 2287, 2288.)

The river and harbor act of July 13, 1892, provided that of the $15,000 appropriated for improving French Broad River, Tennessee, $1,000 "may be used in removing bar or shoal in Little Pigeon River." This sum has been allotted for the removal of the bar near the mouth of the river, described as the only bad shoal below Catlettsburg. No work was done nor expenditures made during the fiscal year ending June 30, 1893.

A working party was organized in October, 1893, and operations were begun and carried on for twenty days in connection with those in progress upon the French Broad River. To overcome the obstruction or shoal near the mouth of the river it was found desirable to excavate the channel at Gass Reef and to use the excavated material and loose rock in building riprap dam.

No work was done on the existing project for Little Pigeon River during the fiscal year 1894–95.

The only improvement possible would be to place a dam in the chute behind Bryant Island to back up the water.

At present a yawl could not reach Sevierville, 5 miles from the mouth of this river.

Total amount expended to close of fiscal year ending June 30, 1894, was $633.10.

The balance of the estimate for the proposed improvement is $8,000, of which $1,000 might be profitably expended during the next two fiscal years in building the dam above mentioned and in cutting trees.

Estimate of cost of improving French Broad River, Tennessee, from mouth to Leadvale	$150,000.00
Amount appropriated	68,000.00
Amount allotted for Little Pigeon River, acts of July 13, 1892, and August 17, 1894	2,000.00
Amount received, sale of steamer *McPherson*	900.00
Amount expended, including outstanding indebtedness, French Broad River	63,463.25
Amount expended, including outstanding indebtedness, Little Pigeon River	633.10

Money statements.

FRENCH BROAD RIVER.

July 1, 1894, balance unexpended	$361.33
Amount appropriated by act of August 17, 1894	6,000.00
	6,361.33
June 30, 1895, amount expended during fiscal year	792.95
July 1, 1895, balance unexpended	5,568.38
July 1, 1895, outstanding liabilities	1,134.83
July 1, 1895, balance available	4,433.55
Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	31,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March, 3, 1893.	

LITTLE PIGEON RIVER.

July 1, 1894, balance unexpended	$366.90
Amount appropriated by act of August 17, 1894	1,000.00
July 1, 1895, balance unexpended	1,366.90
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS OF FRENCH BROAD RIVER, TENNESSEE.

Articles.	Year ending December 31—		
	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*
Grain	.....	8,600	28,933
Lumber	.....	2,200	5,733
Flour	.....	300	733
Live stock	.....	580	453
Wood	.....	150	.....
General merchandise	12,500	5,595	13,546
Total	12,500	17,425	49,398

List of steamboats (stern-wheel) plying on French Broad River.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Telephone	93	19	2.6	97.47
Lucile Borden	86	14	2.5	55.32
C. M. Fouche	96	14	3	61.13
Tallassee	60	12	2	22.16
Onega	104.6	18	2.5	74.77

B B 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga and 79 miles below Knoxville, the length of its course in Tennessee being about 230 miles.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river, about 1,436 square miles, is mountainous and has very meager transportation facilities.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. Osborn Ford, Virginia, about 35 miles northeast of the Tennessee line, is regarded as the head of high-water navigation on the Clinch River. It has no low-water navigation. (See Report of Chief of Engineers, 1865, pp. 736–747.) An examination of the Clinch River from Nash Ford, Virginia, to Hayne (or Walkers Ferry) Tenn., a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1864–1867.) The original project, submitted in 1876, provided only "to improve the high-water navigation of this river, so that there shall be less difficulty and danger in bringing out cargoes, and so that rain tides of 3 or 4 feet may be made use of for boating purposes." This was estimated at $26,400. In 1881 the engineer officer in charge reported that he hoped to attain a permanent increase of depth of water in channel by blasting rock, etc., "securing for about 145 miles of the lower river at ordinary low water, from its mouth to Clinton, about 2 feet, and from Clinton to Walker Ferry (Hayne) about 1½ feet," adopting the low-water channel, which in 1876 had been simply suggested as a channel that might be found practicable after a careful survey, and thus modifying the then existing project, but without increasing the original estimate, which was simply for high-water navigation, by the cost of the channel projected. In 1885 the estimate was increased to $50,000, "because it had been found necessary to make the channel from two to three times the width thought sufficient when the original estimates were made," but the estimate was not increased, although the proposed low-water navigation instead of the high-water navigation was adopted as part of the present project; therefore the balance of the original estimate as modified and remaining unappropriated, $11,000, is manifestly inadequate to complete the work as projected.

The examinations made of the Clinch River are not sufficient whereon to base an estimate of the cost of the projected low-water channel below Walker Ferry, but if radical improvement is to be undertaken it is recommended that a detailed survey be made to obtain the data

necessary to determine the cost, having in view an advantageous and economical prosecution of the work.

Above Walker Ferry to the Tennessee State line, about 85 miles, the only projected improvement is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation and rafting during "rain tides."

The following appropriations have been made for this improvement:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$4,000
March 3, 1881	3,000	July 13, 1892	4,000
August 2, 1882	3,000	August 17, 1894	2,500
July 5, 1884	5,000		
August 5, 1886	5,000	Total	41,500
August 11, 1888	5,000		

The total amount expended to June 30, 1894, including outstanding indebtedness, was $36,710.54; the general results attained by this expenditure are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun.

Above Hayne (or Walker Ferry) special advantages were secured about ten years ago at Hunter Shoals, Sycamore Shoals, Hopson Shoals, and Straight Shoals.

Below Walker Ferry (Hayne) important work has been done at Black Shoals and Bletcher Shoals; at Cloud Shoals seven dams have been built and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have lessened the dangers to navigation. At Llewellyn Shoals the improvements completed consist of reducing projecting rocky points, removing snags, sand, and gravel from the channel, completing wing dams, and constructing dam 190 feet long about 324 feet below Moore Ferry or Ford. Safe navigation at these shoals is now reported possible at a stage of water from 1 to 1½ feet lower than before the work done in 1892 was begun. At Young Island the fish-trap dam was taken from the chute south of the island, but more work is necessary to confine the water to one channel for the floating of logs to the mills below the island.

In July, 1892, partial examinations were made below the mouth of Powell River, and in October below the mouth of Emory River, having in view the ascertaining, in a general way, of what work is necessary to be done to improve the channel to the extent of securing a navigable depth of 2 feet at ordinary low water.

No channel work was practicable during the fiscal year 1894 until November, 1893; a little work was then done near Given Ford, about one-half mile below mouth of Emory River; 60 cubic yards of loose rock were removed from channel and placed in riprap dams at this point; cold weather and high water setting in, all work was necessarily suspended.

No work was done on existing project during the fiscal year 1894–95.

The amount expended during the fiscal year, including outstanding indebtedness, was $208.84.

Having reference to navigation and commerce upon the lower Clinch River, the Annual Report for 1893 states:

> The section of the river below Clinton, a distance of about 70 miles, is practicable for steamboat navigation during the higher stages of the river, and to increase the length of the season of navigation the present project contemplates the construction of wing dams and other channel work at the most troublesome obstructions. The principal navigation at present consists of logs and zinc ore. Immense tracts

of uncut timber still remain in the country adjacent to this stream, and will for a long time to come require its channel as a means of transportation. The product of the zinc mines is brought down from time to time in flatboats to the reducing works at Clinton. These ore deposits are reported as being very extensive and practically dependent upon the river for transportation.

The Loomis & Hart Manufacturing Company, of Chattanooga, Tenn., reports that about 78 per cent of the logs reaching Chattanooga are run out of the Clinch and its tributaries, the Powell and Emory rivers.

Estimate for improving Clinch River, Tennessee, as modified in 1885	$50,000.00
Amount appropriated	41,500.00
Amount expended, including outstanding indebtedness	36,890.54

Money statement.

July 1, 1894, balance unexpended	$2,318.30
Amount appropriated by act of August 17, 1894	2,500.00
	4,818.30
June 30, 1895, amount expended during fiscal year	177.50
July 1, 1895, balance unexpended	4,640.80
July 1, 1895, outstanding liabilities	31.34
July 1, 1895, balance available	4,609.46
Amount (estimated) required for completion of existing project	8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	8,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS OF CLINCH RIVER, TENNESSEE.

Articles.	Year ending December 31—		
	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*
Grain		94	1,220
Flour		10	110
Iron		5	44
Lumber		160	201
Live stock			80
General merchandise		339	11,297
Logs	25,000		
Total	25,000	608	12,932

List of steamboats (stern-wheel) plying on Clinch River.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Key City	80	16	3	59.45
Kingston	55	11	3.7	37.89
Clinton B. Fisk	100	18	3.4	78.89

APPENDIX C C.

IMPROVEMENT OF OHIO RIVER, AND OF MUSKINGUM RIVER, OHIO.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating snag boat on Ohio River.
3. Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.
4. Movable dam in Ohio River below mouth of Beaver River, Pennsylvania.
5. Ice harbor at mouth of Muskingum River, Ohio.
6. Muskingum River, Ohio.
7. Operating and care of locks and dams on Muskingum River, Ohio.
8. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION AND SURVEYS.

9. Ohio River at Ironton, Ohio.
10. Evansville Harbor, Indiana.
11. Muskingum River, Ohio, from Zanesville to Dresden.

UNITED STATES ENGINEER OFFICE,
Cincinnati, July 9, 1895.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1895.

During the year I was assisted by Capt. William C. Langfitt, Corps of Engineers, U. S. A.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Lieut. Col. of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF OHIO RIVER.

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriations.	Allotments.	Remarks.
Mar. 3, 1827	$30,000.00		
Mar. 3, 1835	50,000.00		
July 2, 1836	20,000.00		
Mar. 3, 1837	60,000.00		
July 7, 1838	50,000.00		
June 11, 1844	100,000.00		
Mar. 3, 1847	6,479.25		
Aug. 30, 1852	90,000.00		
June 23, 1866		$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do		80,000.00	Snag boats and apparatus for improving western rivers.
Mar. 2, 1867	100,000.00		
July 25, 1868		85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	50,000.00		
Mar. 3, 1871	50,000.00		
June 10, 1872	200,000.00		
Mar. 3, 1873	200,000.00		
June 23, 1874	150,000.00		
Mar. 3, 1875	300,000.00		
Aug. 14, 1876	175,000.00		
June 18, 1878	300,000.00		
Do	50,000.00		Harbor of refuge at or near Cincinnati.
Mar. 3, 1879	250,000.00		
June 14, 1880	250,000.00		
Mar. 3, 1881	350,000.00		
Mar. 21, 1882	100,000.00		Continuing work on Davis Island Dam.
Aug. 2, 1882	350,000.00		
Do	16,000.00		Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00		
Do	17,000.00		Do.
Aug. 5, 1886	375,000.00		
Aug. 11, 1888	380,000.00		
Sept. 19, 1890	300,000.00		
July 13, 1892	360,000.00		
Aug. 17, 1894	250,000.00		
	5,579,479.25	337,000.00	
Deduct amounts transferred to other works	125,168.48		
Total	5,454,310.77	337,000.00	

The general plan for improving the navigation of the Ohio River now in process of execution is to secure additional depths at islands and bars by the construction of low dams across chutes, and by building dikes where the river is wide and shallow, so as to confine the flow to a smaller cross section, and by dredging. A radical improvement of the upper part of the river has been commenced by the construction of a lock and movable dam at Davis Island, 5 miles below Pittsburg, and work on another lock and dam, No. 6, has been commenced just below Beaver, 29½ miles from Pittsburg. Surveys have also been made for sites for movable dams Nos. 2, 3, 4, and 5 of the series. A snag boat and two dredges belonging to the United States are constantly employed when funds are available and the stage of river permits in taking out snags and wrecks and in dredging away gravel and rock obstructions that can not otherwise be removed. When necessary, additional dredging plant is hired, the plant belonging to the United States not being sufficient to do all the work required.

At the commencement of the year the following projected works were unfinished:

	Miles below Pittsburg.
Logstown Bar, 2 dikes	18
Clusters Islands, 4 dikes and 1 dam	52
Mouth of Licking River, excavation of rock bar	466½
French Island, 2 dikes and 1 dam	761
Scuffletown, 2 dikes	767
Tradewater Bar, 1 dike	862
Mound City, Ill., 2 dikes	959

The following works were in progress during the year:

Dam between Davis and Neville islands, 4.75 miles below Pittsburg.—The paving of eight of the lower cribs having been washed out during the previous winter, it was replaced in July and the dam put in good condition.

Dikes at Logstown Bar, 18.5 miles below Pittsburg.—Work at this place in accordance with the plan recommended by the Board of Engineers was resumed on the main cross dike and training dike in July, 1894, and these structures were completed in August, 1894. In addition to completing the work, of which only a gap of 125 feet in the training dike was left unfinished at the close of the fiscal year ending June 30, 1894, some minor repairs rendered necessary by the floods of the winter of 1893–94 were made. Although the new dike caused some desirable effects the permanency in form and position of the bar in its front suggested that there must be some unusual cause preventing the continuance of the scour already caused by it and the consequent formation of a channel which would naturally be expected to follow the completion of this dike. A study of recent maps and comparison with those of older date showing the position of the old dikes put in at this place about 1832 and about 1868 pointed to the presence of the portion of the dike put in in 1832, reported by Mr. Roberts as removed when the 1868 dike was constructed, as an obstacle preventing the scouring out of the desired channel. Subsequent examination confirmed the supposition and the old dike was traced over a distance of 805 feet, lying diagonally across the proposed channelway. A force was put to work to remove it in September, 1894, but after excavating it for its full width to a depth of 2 feet over a length of 25 feet a rise in the river caused cessation of the work. This work was afterwards completed by the United States dredges in September and November, 1894, 1,946 cubic yards of loose rock and gravel being removed. I stated last year that "while surveys made show favorable action by the work so far done, the closing of the inferior shore channel and dredging out of a straight channel across the bar, which were parts of the original plan, but omitted in the recommendation of the Board on account of the opposition of the coal men, will, in my opinion, have to be accomplished to render navigation safe and easy at this point." A recent examination shows that the desired channel is not being obtained by the work so far done and fully confirms the opinion quoted. The examination was made by Mr. William Martin, assistant engineer, an extract from whose report is appended.

Dikes, etc., at Clusters Islands, 52 miles below Pittsburg.—A contract was made with L. Cramer & Son, dated June 20, 1893, approved June 29, 1893, work to be completed December 31, 1893, for the construction of 4 dikes, 1 dam, and shore protection at this place. The contract not being completed on the date set, it was deemed to the best interests of the United States to extend their contract to November 30, 1894, under supplementary agreement giving the United States power to enforce proper progress for future work. Under the extension and supplemen-

tary agreement all desired work was completed on September 28, 1894. It was deemed best to omit for the present the shore protection contemplated for the channel side of the outer island until experience has shown more definitely the places that will be attacked by the current. The total amount of material expended in the structures under the contract are as follows:

	Dike No. 1.	Dike No. 2.	Dike No. 3.	Dike No. 4.	Dam.	Total.
Piles.....number..	90	94	70	194	135	583
Timber .....feet, B. M..	10,264.8	10,744.8	7,864.8	22,744.8	19,836	71,455.2
Stone, smaller class...cubic yards..	1,299.5	729.3	449.4	1,913.1	3,388	7,779.3
Stone, larger class .....do....	57	52	35.9	14.9	.....	159.8
Bolts, etc .....pounds..	979	1,011	819	1,811	1,854	6,474
Spikes.....do....	60	60	60	60	.....	240

The work has been under the immediate supervision of Mr. J. Nelson Caldwell, inspector, an extract from whose report is appended.

The work of dredging a channel through the cemented gravel bar lying within the proposed channelway and which was suspended June 29, 1894, by low water, was resumed in November, 1894, 17,678 cubic yards of gravel and bowlders being removed, together with 4 rocks weighing 13 tons, between November 12 and 28.

While it is known that the effect of the work so far done has been very beneficial, as soon as possible after the stage of river will permit an examination will be made to determine the exact changes so far produced on the channel and what further work, if any, is needed.

Dam at the head of Marietta Island, 168 miles below Pittsburg.—It having been reported that considerable erosion was taking place at the head of this island, an examination showed that the water pooled by the dam across the branch of the river back of it, flowing past the head, had cut out a cross channel there and was washing away the head of the island. This cross current was troublesome to navigation and was also increasing the erosion on the opposite or Ohio bank of the river. To stop these injurious effects it was decided to build a dam across this channel and to protect the head of the island so much as was necessary. This work was done during October and November, 1894, 1,479.9 cubic yards of stone being used. This work was under the immediate supervision of Mr. Edmund Moeser, assistant engineer, extracts from whose reports are appended. A recent examination, June, 1895, shows that the works are producing beneficial effects, but the erosion of the Ohio-shore bank, due to a considerable extent to the closing of the channel back of the island, continues, and the bank should be protected. A small amount of damage was done to the back channel dam by the ice of the past winter, but it is slight and will not require extensive repair.

Dike near foot of Blennerhassetts Island, 188 miles below Pittsburg.—The work proposed for the improvement of the crossing here consists of a loose stone dike on left bank about 550 feet in length to confine the river at low stages to a narrower channel and a small amount of dredging to open a channel between the deep water above and below the bar and as an aid to the scouring effect of the dike. The dike is to be built to an elevation of 4 feet above low water. Under contract with J. T. Hart, dated April 29, 1895, approved May 3, 1895, work on the dike was commenced May 14, 1895, and at the close of the year was still in progress, 3,579 cubic yards of stone having been placed in the work. The dike is nearly completed. The dredging desired was done by the U. S. dredges *Ohio* and *Oswego* May 16 to May 25, 1895, 11,680 cubic yards of material being removed and deposited near the left bank

about 1,000 feet below the location of the dike. It is thought this deposit will aid the dike in formation and maintenance of the desired channel. A survey of the locality was made before work was begun. The channel shows marked improvement.

Ice piers.—The river and harbor act of August 17, 1894, contained the following clause:

> Improving Ohio River, Ohio: Continuing improvement, two hundred and fifty thousand dollars, of which * * * dollars shall be used in continuing the work at * * * ; eighteen thousand seven hundred and fifty dollars, or so much thereof as may be necessary, in constructing an additional ice pier at Middleport, Ohio, pursuant to the plans of the Chief of Engineers, and in enlarging and improving the ice pier at Pomeroy, Ohio, and in constructing an ice pier at or near Syracuse, Ohio, or at or near Hartford, West Virginia, upon the plans heretofore adopted for such piers in the Ohio River. The precise points for the construction of said piers at said localities shall be fixed by the Secretary of War so as to best accommodate the commerce of those sections of said river.

The preliminary surveys necessary to carry out this provision have been made and preparation of project is about completed.

Under somewhat similar provisions ice harbors have been created at various other places along the Ohio River. The following table shows, first, the locality where built; second, the distance below Pittsburg, and third, the distance between consecutive harbors of those already built and the additional one authorized in the clause quoted. A general description of their construction is given in my annual report for 1893.

The harbor at the mouth of the Muskingum River consists simply of the first pool of the slack-water navigation of that river, a lock specially designed to accommodate Ohio River commerce giving entrance to this pool from the Ohio, which will soon be available, provision having been made for changing the railroad bridge just below the lock, which has heretofore blocked the entrance.

Name of locality.	Distance below Pittsburg.	Distance from harbor above it.	Remarks.
	Miles.	*Miles.*	
1. Mouth of Muskingum River	171	.....	
2. New Haven or Syracuse	243	72	Approximate.
3. Kerrs Run	247	4	Do.
4. Pomeroy	248	1	
5. Middleport	249	1	
6. Mouth of Great Kanawha River	263.5	14.5	
7. Gallipolis	267	3.5	
8. Ironton	325	58	
9. Portsmouth	353.5	28.5	
10. Ripley	414	60.5	

The past winter was quite a severe one, navigation being suspended at Cincinnati for a period of about twenty-one days. Letters were addressed to the mayors of towns where harbors exist, requesting information as to the use made of them during the past winter. As a general summary of the replies received it may be stated that the harbors, with one or two exceptions, proved of great service to navigation, many steamers and barges taking refuge in them from the ice.

Dikes at Guyandotte Bar, 303 miles below Pittsburg.—The work projected consists of the construction of four loose stone dikes to be built to an elevation of 3 feet above low water, and to have the following approximate lengths:

	Feet.
No. 1, on right bank	860
No. 2, on right bank	550
No. 3, on right bank	640
No. 4, on left bank	210

The object of these dikes is to confine the water to a narrower channel at low stages, in addition to scouring the channel in front. Their effect is to be supplemented by considerable dredging, as the bottom here consists in large part of heavy bowlders and compact gravel which the current is incapable of moving. The dredging will also remove an elongated pile of stone or dike lying in the proposed channel way. This stone was placed here by the town of Guyandotte some years ago to better the channel. Under contract dated April 27, 1895, and approved May 2, 1895, with J. C. Thomas, work was commenced on May 10, 1895, and at the close of the year was still in progress, 5,070 cubic yards of stone having been deposited in place by the contractor.

The dredging at this place is now in progress by the U. S. dredges *Ohio* and *Oswego*, work commencing May 27, 1895, and the following amounts of material have been removed: Loose rock, bowlders, and cemented gravel, 22,576 cubic yards; large rocks, 204, aggregating 95.3 tons, and 2 logs weighing 0.9 tons. The work has materially improved the channel.

Rock Bar at mouth of Licking River, 466.5 miles below Pittsburg.—As stated in previous reports, the present project contemplates the continuance of the excavation of this bar by submarine blasting, from a boat equipped with steam drills, and subsequent dredging. At the close of the last fiscal year work was suspended. It was resumed under a new allotment October 29, 1894, and suspended for the season December 15, 1894. It was resumed again June 1, 1895, and at the close of the year is still in progress. The economy of the method of work adopted has again been shown most satisfactorily. The total amount of material removed October to December, 1894, was 6,882.6 cubic yards, of which 5,465.94 cubic yards was taken to Medoc Bar and deposited so as to form the body or core of a dike needed there. During June, 1895, the work was confined to drilling and blasting.

The work is under the immediate supervision of Mr. R. R. Jones, assistant engineer, an extract from whose report is appended.

Dike at Medoc Bar, 485 miles below Pittsbury.—A survey was made in September, 1894, to determine what further work was necessary. The resulting project approved September 25 provided for the removal of a portion of the old 1871 dike and construction of one new dike. In October a dredge was hired which excavated the portion of the 1871 dike as desired, the amount of material removed on boats being 1,224 cubic yards, of which 1,074 cubic yards was stone, and was deposited so as to form a head to the shortened dike. The remainder was sand, of which also large quantities were washed out of the buckets while being raised. Under ten-day proposals, an agreement was made with Messrs. Hayman and Harrell, of Cincinnati, Ohio, to furnish the stone for the new dike. Beyond offering one bargeload, rejected as not up to the requirements, they made no attempt to carry out their agreement. There being no other bid at a reasonable price, it was then decided to partially construct the dike with material removed from the mouth of the Licking River. This work was commenced on November 13 and completed December 10, 5,465.94 cubic yards of material being deposited in dike, and of which about 72 per cent was rock and 28 per cent gravel. In the deeper portions the finer material was carried downstream, forming a flatter slope than if stone alone had been used, but the cheapness of construction more than justifies the excess of material used. The body of the dike thus formed was carried to an elevation of about 3 feet on the Cincinnati waterworks gauge. It is proposed to complete it by a top covering of quarried rock. Beneficial

effects of the work on this bar were observed at once, and experience so far this season by boats points to a marked improvement of the channel both in depth and direction. The work was done under the immediate supervision of Mr. R. R. Jones, assistant engineer, an extract from whose report is appended.

Gunpowder Bar, 509 miles below Pittsburg.—The work projected consists of two loose stone dikes, running out from the right shore, to confine the water at low stages to a narrower channel. They are to be 4 feet in elevation above low water and their action is to be supplemented by dredging. The length of Dike No. 1 is, approximately, 470 feet, and of Dike No. 2, 460 feet. Under contract with William A. Kirk, dated April 26, 1895, and approved May 2, 1895, work on the dike was commenced May 17, 1895, and at the close of the year was in progress. The following amounts of material have been placed by the contractor: In Dike No. 1, 1,727.4 cubic yards; in Dike No. 2, 1,813.6 cubic yards. The works are not sufficiently far advanced to produce much effect on the channel, and dredging has not yet been commenced.

Flint Island, 683 miles below Pittsburg.—The work projected consists of five loose stone dikes to confine the water at low stages and to scour out a channel, their action in this respect to be aided by dredging. For the improvement of this place there was constructed in 1891 a long curved dike, joining the right shore at its upper extremity. Nos. 1 and 2 of the projected new dikes are to be short dikes extending out from this long curved dike. In accordance with the approved project, they will be constructed by hired labor from material taken from the curved dike, which it is designed to lower somewhat in order to reduce the tendency of water falling over it at higher stages and forming a deep channel or pool behind it. Dike No. 3, approximately 1,420 feet in length, extends out from the right bank just below the lower end of the curved dike. In addition to aiding in forming the channel beyond it will close the channel behind the curved dike and cause this space to fill up. Dikes Nos. 4 and 5, of approximate lengths, respectively, of 50 and 140 feet, extend out from the right bank. These dikes are to be from 4 to 6 feet in elevation above low water. Under contract with Patterson & Shipman, dated April 29, 1895, and approved May 8, 1895, work of construction of Dikes 3, 4, and 5 was begun on May 9, 1895, and at the close of the year was still in progress, the following amounts of stone having been put in place in each dike:

	Cubic yards.
Dike No. 3 (completed)	3,688
Dike No. 4	435.9
Dike No. 5	679.3

The dredging contemplated was commenced May 9, 1895, and completed June 18, 1895, with a dredging plant hired for the season from William A. Kirk, of Madison, Ind. The amount of material removed was 14,260 cubic yards, most of which was deposited roughly in form of a dike about 1,000 feet below Dike No. 3 and near the same shore, to aid in the formation of the desired channel. The dredge also removed two wrecks which were directly in the channel. An examination is now in progress to determine what changes have taken place.

French Island, 761 miles below Pittsburg.—A contract was made with William Kirk, dated June 20, 1893, approved June 30, 1893, work to be completed December 31, 1893, for the construction of two dikes and one dam. The work not being completed at date set, it was deemed to the best interests of the United States to extend the contract to November 30, 1894. Work under the extension was resumed in August, 1894,

and completed in November, 1894. The following are the total amounts of materials expended in the dikes and dam:

Timber	feet, B. M..	39,300
Piles	number..	350
Stone, smaller class	cubic yards..	10,337.5
Bolts, etc	pounds..	3,540
Spikes	do....	150

At the close of the last fiscal year a dredging fleet, hired for the purpose, was engaged in removing that portion of an old dike, built in 1832, that lay in the way of the proposed channel. The fleet was engaged on this work from June 8 to July 11, and from August 3 to December 8, 1894, when operations were suspended for the season. This old dike proved to contain a large amount of stone, and was in places scattered over 300 feet in width. The work was much hampered by the low stage of water. Its removal has therefore proved costly, but was necessary to the improvement of the channel, and it is believed that, with possibly the exception of a little in the shoulder of a gravel bar which, at the time work ceased, projected into the channel and did not seem to scour away as was desired, it is thoroughly removed within the proposed channel lines. The total amount of material dredged was about 50,000 cubic yards, consisting of sand, gravel, and stone from the old dike.

After completing the dredging laid out for Flint Island, the plant there was moved to this place, arriving June 19, since which date dredging the shoulder mentioned has been in progress. At the close of the month 2,880 cubic yards of material had been excavated. A recent examination shows that the channel way is being formed as desired, and a good channel is hoped for during the ensuing low-water season. The work was under the immediate supervision of Mr. H. Devereux, inspector, an extract from whose report is appended.

Vanada Reef and Falls Slough Crossing, 764 miles below Pittsburg.—The works projected at these two points, which are about 1½ miles apart, consist of two loose stone dikes extending out from the right bank to confine the river to a narrower channel at low stages. Dike No. 1 at Vanada Reef is to be approximately 1,320 feet, and Dike No. 2 at Falls Slough Crossing 670 feet in length; No. 1 is to be 4 and No. 2 3 feet in elevation above low water. Some dredging is also contemplated to aid the dikes in forming the channel. Under contract with Bedford, Weikel & Nugent, dated April 27, 1895, approved May 8, 1895, work was commenced May 1, 1895, and at the close of the year was in progress, the following amounts of stone having been put in place in each dike:

	Cubic yards.
Dike No. 1	4,282
Dike No. 2	1,506

The works are not sufficiently advanced to have their effect on the channel.

Scuffletown Bar, 767 miles below Pittsburg.—A contract was made with L. Cramer & Son, dated June 20, 1893, approved June 29, 1893, for the construction of two dikes, work to be completed December 31, 1893. The contract not being completed on the date set, it was deemed to the best interests of the United States to extend their contract to November 30, 1894, under supplementary agreement giving the United States power to enforce proper progress for future work. On November 30 the work was not quite completed, and a second extension was granted to December 31, 1894. Under the extensions work was com-

pleted December 18, 1894. The effect of these works, so far as observed, has been beneficial, boats having had no trouble there this season. As soon as possible after the stage of river is favorable, examination to determine the effect produced will be made. The following is a statement of work done and materials expended:

Class of material.	Previous to June 30, 1894.	Since June 30, 1894.	Total.	Price.	Cost of material.
Length of dike built, upper dike.....feet..	500	250	750	.....	.....
Length of dike built, lower dike.....do....	1,050	480	1,530	.....	.....
Piles.....number..	306	219	525	$2.50	$1,312.50
Timber.....feet, B. M..	6,960	53,390	60,350	20.00	1,207.00
Bolts, nuts, and washers.....pounds..	478	4,009	4,487	.05½	246.78
Spikes, kegs of 150 pounds.....number..	.....	2	2	6.50	13.00
Excavation, root of dikes.....cubic yards..	143	.....	143	.25	35.75
Stone, larger class.....do....	.....	225	225	1.10	247.50
Stone, smaller class.....do....	3,874	4,589	8,463	.94	7,955.22
Total cost.....	.....	.....	.....	.....	11,017.75

Cut-off near Evansville, Ind., 783 miles below Pittsburg.—The river and harbor act of August 17, 1894, contained the following item:

Twenty-five thousand dollars, or so much thereof as may be necessary, in preventing the cut-off threatened at the peninsula near Evansville, Indiana;

The necessary surveys have been made and platted to determine the best method of carrying out the above provision, and the work will be taken in hand as soon as practicable.

Dikes at Three Mile Island, 773 miles below Pittsburg.—The works projected for this place consist of six loose stone dikes, of which Nos. 1 to 4, inclusive, extend out from the right shore, and Nos. 5 and 6 from the left shore. They are all to be built to an elevation of 4 feet above low water. Their approximate lengths are to be as follows: No. 1, 290 feet; No. 2, 300 feet; No. 3, 100 feet; No. 4, 90 feet; No. 5, 500 feet, and No. 6, 1,150 feet. Under contract with Bedford, Weikel & Nugent, dated April 27, 1895, approved May 8, 1895, work was commenced May 9, 1895, and at the close of the year was in progress, 3,825 cubic yards of stone having been put in place in the dikes.

The works are not sufficiently advanced to produce the effects desired.

It being reported last season that boats were having trouble at this place, the dredge which was employed at French Island was sent here during the latter part of July, 1894, to dredge a channel through the bar. A cut 1,300 feet long and 35 feet wide was made to a depth of 4 feet below low water, which materially relieved the difficulties experienced.

Levee at Shawneetown, Ill., 848 miles below Pittsburg.—The river and harbor act of August 17, 1894, set aside $12,000 from the funds appropriated for the improvement of the Ohio River to be expended on this levee. The work desired by the citizens of the place consisted in strengthening certain portions of the levee by addition of earth to the outside or water slope; in extending the stone revetment over another portion more or less exposed to wash, and in repairing the levee where necessary. Under project dated November 9, 1894, and approved November 13, 1894, the earthwork and stone revetment were to be done by contract after due advertisement, and the repairs by hired labor. Contract was accordingly made with the Du Pont Improvement Company, of Owensboro, Ky., dated December 21, 1894, approved December 31, 1894, to be completed March 31, 1895, for the earthwork. Owing to continued unfavorable weather the contractor was not able to complete the work in time and the contract was extended to May 15, 1895. Work

was commenced January 20, 1895, and completed May 12, 1895, about 15,000 cubic yards of earth having been put in place. Under the contract the final cross section to determine the exact amount of earth placed may, in the discretion of the engineer officer in charge, be delayed for three months to allow for settlement. These final cross sections have not been taken. Contract was also made with Hampton G. Grainger, of Caseyville, Ky., dated February 7, 1895, approved February 20, 1895, work to be completed June 1, 1895, for the delivery in place of the stone revetment. Work was begun March 9, 1895, and completed April 30, 1895, 2,249.2 cubic yards of stone being used. During the progress of the two contracts all necessary repairs were made over the whole length, about 4 miles, of the levee. It is now believed to be amply strong and in good repair throughout.

Dike at mouth of Tradewater River, 862 miles below Pittsburg.—A contract was made with William Kirk, dated June 20, and approved June 30, 1893, for the construction of one dike to be completed December 31, 1893. Work not being completed at the date set, the contract was extended to November 30, 1894. Under the extension work was resumed August 23, 1894, and the 1,879 feet under construction were completed November 27, 1894. The following table gives the total amount of material expended in this work:

Timber	feet, B. M..	44,240
Piles	number..	368
Brush mats	square yards..	2,965.8
Binding poles	linear feet..	2,100
Stone (smaller size)	cubic yards..	11,372.1
Bolts, etc	pounds..	2,812

This dike extends out from the right or Indiana shore. Examination having shown that the dike was forcing more water to flow through the channel between bar and the Kentucky shore, and that a good low-water channel could be developed here by the scour induced aided by dredging, during November and December, 1894, scrapers were employed to remove a part of a small, hard gravel bar, and a portion of the shoulder of the main bar, lying in the way of the proposed channel. The gravel removed, about 12,894 cubic yards, was mainly above extreme low-water surface and the excavation was much cheaper by this method than to have employed dredging. The United States snag boat also removed from this channel in December, 1894, a number of snags, wrecks, and bowlders. An examination made in May, 1895, showed a continuance of the scour in this back channel during the winter, but owing to the compact nature of the material further dredging was shown to be neccessary in order that a good low-water channel might be obtained by the time the river should get to its low stages. Under contract with H. S. Brown, of Quincy, Ill., a dredging plant hired for the season commenced operations May 17, 1895, and at the close of the year was still at work, 14,940 cubic yards of sand and gravel, 7 snags, 3 wrecks, and a large quantity of drift having been removed.

As stated in report of last year the extension of the dike was suspended after it had reached a length of 1,879 feet until its action on the bar could be further observed. The question of its extension, about 400 feet, to the length contemplated in the original plan is still held in abeyance, pending future observations on the scouring action induced and the effects on the proposed channel way.

Dikes at Mound City, Ill., 959 miles below Pittsburg.—A contract was made with Frederick Hartweg, dated June 20, approved June 30, 1893, for construction of two dikes, to be completed December 31, 1893. The work not having been completed on the date set the contract was ex-

tended to November 30, 1894. The stage of water at this place remained too high throughout the working season to permit the contractor to give the stone its proper arrangement and to put on the curbing timbers. Supplementary articles closing the contract were therefore entered into. All the stone required was delivered, and the following are the total amounts of material expended in the work:

Piles	number..	258
Brush mats	square yards..	4,389
Binding poles	linear feet..	3,120
Stone, larger class	cubic yards..	60
Stone, smaller class	do....	7,668.1

To aid the dikes in the formation of the channel and to relieve navigation a dredging plant was employed to cut a channel through the bar and to remove some high areas interfering with free navigation. The work of dredging began September 26, 1894, and was suspended for the season December 18, 1894—31,768 cubic yards of material having been removed. The channel cut through the bar showed evidences of widening, due to scouring action, and the work has been very beneficial. The dredging was much interfered with by a hard conglomerate, which will require drilling and blasting before the channel can be excavated to the full depth desired. Further dredging is proposed during the ensuing season together with the removal of so much of the conglomerate mentioned as may be necessary.

Operations of United States dredges.—The dredging fleet remained in winter quarters in the mouth of the Kentucky River until April 26, when it was taken to Cincinnati for necessary repairs. These were completed and the fleet left Cincinnati May 8, and began the season's work at Clusters Islands May 14, 1894. During the calendar year 1894 the fleet worked at the following places removing the material shown:

	Material dredged.	Rocks.		Snags.		Wrecks.
		No.	Weight.	No.	Weight.	
	Cu. yds.		*Tons.*		*Tons.*	*No.*
Clusters Islands	53,072	8	28.6			
Brimstone Run Bar, Ohio	5,007	1	14.8			
Head of Brunots Island	95,383			1	0.4	
Foot of Brunots Island	23,095	4	6.1	1	1.8	1
Davis Island Dam						2
Logstown Bar	1,946					
Horsetail Ripple						2
Mouth of Muskingum River	2,595			3	6.6	

The work at Brunots Island in Pittsburg Harbor was especially needed, as the channel past the island had been deteriorating for some years, causing a large number of wrecks there at scant towboat stages. Further work is still needed at this locality. The fleet went into winter quarters in the mouth of the Muskingum River in December, 1894. The annual repairs for the season of 1895 were made there during parts of April and May, 1895, and the season's work began May 13, 1895. So far this season the fleet has worked as follows:

Locality.	Amount.	Material removed.
Marietta, Ohio, cubic yards..	1,230	Soft gravel.
Foot of Blennerhassetts Island, do....	11,680	Do.
Do	1	Log.
Head of Vienna Island	1	Wrecked coal barge.
Guyandotte Bar, cubic yards..	22,576	Bowlders and cemented gravel.
Do	204	Large rocks.
Do	1	Log.

A detailed report of operations for the calendar year 1894 is given by Mr. E. J. Carpenter, assistant engineer, in immediate charge of the fleet, an extract from which is appended.

Special surveys of Ohio River.—Special surveys have been made at the following localities to determine the needs of the places named:

	Miles below Pittsburg.
Foot of Blennerhassetts Island	188
Guyandotte Bar	303
Eight Mile Bar	458½
Cullums Ripple	471½
Medoc Bar	485
Rising Sun Bar	502
Flint Island	683
Vanada Reef and Falls Slough Crossing	764
Cut-off near Evansville, Ind	771
Three Mile Island	773

Special surveys for location of the ice piers required by the river and harbor act of August 17, 1894, were also made.

Encroachments.—Information has been received at various times that certain parties were dumping material into the river or over its banks or building structures which would prove obstructions to the waterway. Investigations have been made and when necessary the matter has been reported to the United States district attorney for his action.

Harbor lines.—The present boards of engineers, having under consideration the harbor lines at Pittsburg, Wheeling, and Cincinnati, have made their reports on the lines at Wheeling and Pittsburg, which reports and accompanying maps have been approved by the Honorable Secretary of War and the Chief of Engineers.

The reports and maps for Cincinnati are in process of preparation, and it is hoped to complete them at an early day. This will complete this work, except the necessary surveys for and placing of monuments for locating the lines.

STAGES OF THE OHIO RIVER DURING 1894.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the upper, middle, and lower Ohio:

Gauge of Davis Island Dam, near Pittsburg, Pa.

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	27	10.2	5.1
February	0	28	26	14.5	5.4
March	0	31	31	13.8	6.5
April	0	30	28	12.1	5.8
May	0	31	20	21.8	4.1
June	0	30	12	9.8	3.2
July	27	3	0	3.6	1.6
August	31	0	0	2	1.1
September	12	18	5	11.5	.7
October	24	7	0	3.6	2
November	0	30	2	6.3	3
December	0	31	17	10	3.9
Total	94	270	168	.....	.....

Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	21	15.4
February	0	28	28	35.6	17.2
March	0	31	31	27.5	17.8
April	0	30	30	25.3	14.2
May	0	31	31	32	9.4
June	0	30	30	20.6	7.5
July	0	31	12	8	4.1
August	0	31	0	5.1	3.5
September	0	30	5	12.8	3.1
October	0	31	5	9	3.5
November	0	30	19	8.9	3.5
December	0	31	31	19.4	6.8
Total	0	365	253	.....	.....

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 3 feet in he channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	17.9	10.8
February	0	28	28	31.8	13.5
March	0	31	31	21.4	16.3
April	0	30	30	21.9	13.5
May	0	31	31	22.5	8.3
June	0	30	26	20.7	5.6
July	13	18	0	5.6	1.7
August	31	0	0	1.9	1.5
September	30	0	0	2.4	.5
October	21	10	3	6.8	.7
November	18	12	0	4.6	.7
December	0	31	20	12.4	3.7
Total	113	252	200	.....	.....

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River. The general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati Suspension Bridge shall have a draw for use in high water, unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge at Louisville is exceptionally located, and no record of its operation is kept. Reports received from the Cincinnati Southern Railroad Bridge at Cincinnati, and the Kentucky and Indiana Bridge at Louisville, state that the draws were not opened for the passage of boats during the calendar year ending December 31, 1894.

STOPPAGE OF NAVIGATION BY ICE.

The winter of 1894–95 was a comparatively severe one, navigation having been stopped at Cincinnati by danger from ice from February 6 to February 27, 1895. The river was completely closed from the 9th to 25th, but the ice passed out doing but little if any damage at Cincinnati.

LOSSES BY COLLISION WITH BRIDGES.

The following table shows the losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River, between July 1 and December 31, 1894:

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Parkersburg Bridge:				
Previously reported				$75,677
Dec. 5, 1894	Advance Coal Co	John Moren	1 barge of coal	2,100
Total				77,777

Losses by collision with Ohio River bridges to December 31, 1894.

Beaver Bridge	$56,040.00
Steubenville Bridge	92,308.00
Wheeling and Martins Ferry Bridge	9,800.00
Bellaire Bridge	137,656.00
Parkersburg Bridge	77,777.00
Point Pleasant Bridge	9,600.00
Kenova Bridge	18,700.00
Newport and Cincinnati Railroad Bridge	44,107.00
Covington and Cincinnati Railroad Bridge	43,300.00
Cincinnati Southern Railroad Bridge	9,812.00
Louisville and Jeffersonville Bridge	7,800.00
Ohio Falls Bridge	80,350.00
Kentucky and Indiana Bridge	27,767.00
Cairo Bridge	23,496.65
Henderson Bridge	20,520.00
Total	659,033.65

ESTIMATES.

In work of the character of that for the improvement of the Ohio River it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and therefore it is impossible to submit estimates for complete improvement. The work must be progressive and tentative, and owing to the varied interests and communities along nearly 1,000 miles of river the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand and improvement completed in advance of other parts of the river unless large amounts of money are provided. The great and growing commerce of this river, its numerous cities, and the rapid increase of the already large population of the valley should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods. The sum of $1,000,000 can be profitably used and produce immediate results in great improvement for the movement of the vast commerce of the river. Attention is particularly invited to the commercial statistics appended.

Money statement.

July 1, 1894, balance unexpended		$187,593.47
Amount appropriated by act of August 17, 1894		250,000.00
		437,593.47
June 30, 1895, amount expended during fiscal year		133,031.81
July 1, 1895, balance unexpended		304,561.66
July 1, 1895, outstanding liabilities	$36,354.38	
July 1, 1895, amount covered by uncompleted contracts	45,443.35	
		81,797.73
July 1, 1895, balance available		*222,763.93
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		1,000,000.00

Abstract of proposals for furnishing earth and strengthening embankment at Shawneetown, Ill., received in response to advertisment dated November 20, 1894, and opened at Cincinnati, Ohio, December 6, 1894, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Earth in place (estimate, 15,000 cubic yards).	Aggregate of bid.
		Per cu. yd.	
1	Patterson & Shipman	$0.29½	$4,425
2	Du Pont Improvement Co. *a*	.24	3,600
3	Peter Manion	.29	4,350

a Recommended for acceptance.

Abstract of proposals for furnishing stone for levee at Shawneetown, Ill., received in response to advertisement dated December 22, 1894, and opened at Cincinnati, Ohio, January 23, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Stone in place (estimate, 2,550 cubic yards).	Aggregate of bid.
		Per cu. yd.	
1	Eli Cox	$2.50	$6,375.00
2	W. A. Kirk	1.65	4,207.50
3	Du Pont Improvement Co	1.65	4,207.50
4	Hampton G. Grainger *a*	1.30	3,315.00
5	Halloran & Katterjohn, jr	1.88	4,794.00

a Recommended for acceptance.

*The item in the river and harbor act of August 5, 1886, making an appropriation of $375,000 for improving the Ohio River provides that $37,500, "or so much thereof as may be necessary, of said appropriation, shall be expended in constructing five ice piers, pursuant to the present or prospective plans of the Chief of Engineers, at or near the following places, to wit: One at Pomeroy, Ohio; one at Middleport, Ohio; one at Gallipolis, Ohio; and one at Ironton, Ohio; and one at Ashland, Ky., on the south side of the Ohio River."

All of the ice piers in question have been completed with the exception of the one at Ashland, Ky., for which it was found impossible to secure the relinquishment of riparian rights required by law. Under these circumstances it is recommended that the unexpended balance of this allotment of $37,500, amounting to $11,402.52, still accounted for as available July 1, 1895, be returned to the fund available for the general improvement of the Ohio River.

Abstract of proposals for a dump scow received in response to advertisement dated January 17, 1895, and opened February 1, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Amount of bid.
1	M. A. Sweeney Co	$4,800
2	Edw. J. Howard*	2,750
3	Cincinnati Marine Railway Co	3,484

* Recommended for acceptance.

Abstract of proposals for furnishing two dredging plants, each consisting of 1 dredge, 1 towboat, and 3 dump scows, for use on the Ohio River, received in response to advertisement dated February 23, 1895, and opened at Cincinnati, Ohio, March 26, 1895, by Lieut. W. C. Langfitt for Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Dredge boat and 3 dump scows.		Towboat.	
		Price per day when at work.	Price per day when inactive.	Price per day when at work.	Price per day when inactive.
1	Monongahela and Western Co.:				
	Paducah, Ky	$125.00	$75.00	$75.00	$50.00
	Owensboro, Ky	125.00	75.00	75.00	50.00
2	W. A. Kirk, at Owensboro, Ky.*	40.00	12.50	30.00	15.00
3	H. S. Brown, at Paducah, Ky.*	45.00	15.00	30.00	10.00
4	Eichel, Arnold & Co.†	48.00	24.00	40.00	26.00

* Recommended for acceptance. † Within 200 miles of Evansville, Ind.

Abstract of proposals for building loose-stone dikes in Ohio River, received in response to advertisement dated March 15, 1895, and opened at Cincinnati, Ohio, April 16, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Blennerhassetts Island (estimate, 3,476 cubic yards).		Guyandotte Bar (estimate, 7,905 cubic yards).		Gunpowder Bar (estimate, 4,840 cubic yards).	
		Per cubic yard.	Aggregate of bid.	Per cubic yard.	Aggregate of bid.	Per cubic yard.	Aggregate of bid.
1	E. J. Hulings, H. B. Hulings						
2	Joshua R. King	$1.00	$3,476.00	$1.15	$9,090.75		
3	Patterson & Shipman			1.10	8,695.50	$1.50	$7,260.00
4	Walter S. Ware			1.85	14,624.25	1.95	9,438.00
5	George F. Egan	1.89	6,569.64	1.89	14,940.45	1.89	9,147.60
6	Bedford, Welkel & Nugent						
7	Samuel Monroe, Phillip Kelly	1.25	4,345.00	1.25	9,881.25	1.45	7,018.00
8	Eichel, Arnold & Co						
9	C. F. Crawford, P. Henson			2.95	23,319.75		
10	Thomas H. King	.89	3,093.64	1.75	13,833.75		
11	Oliver Reed			1.07	8,458.35		
12	Josiah Thomas Hart	*.74	2,572.24	.95	7,509.75		
13	P. Halloran, F. W. Katterjohn, jr						
14	L. Cramer & Son						
15	William A. Kirk					*1.00	4,840.00
16	L. Cramer & Son	1.10	3,823.60	1.14	9,011.70	1.35	6,534.00
17	J. C Thomas			*.80	6,324.00		
18	William D. Crammond						
19	Gardner & Cook			2.10	16,600.50		
20	Henry L. Wright			2.74	21,659.70		
21	Du Pont Improvement Co						

* Recommended for acceptance.

Abstract of proposals for building loose-stone dikes in Ohio River, etc.—Continued.

No.	Name of bidder.	Flint Island (estimate, 4,576 cubic yards).		Vanada Reef and Falls Slough Crossing (estimate, 9,174 cubic yards).		Three Mile Island (estimate, 11,066 cubic yards).	
		Per cubic yard.	Aggregate of bid.	Per cubic yard.	Aggregate of bid.	Per cubic yard.	Aggregate of bid.
1	E. J. Hulings, H. B. Hulings			$1.17	$10,733.58	$1.20	$13,279.20
2	Patterson & Shipman	*$0.95	$4,347.20	1.10	10,091.40	1.10	12,172.60
3	George F. Egan	1.89	8,648.64	1.89	17,338.86	1.89	20,914.74
4	Bedford, Weikel & Nugent			*.91½	8,371.28	*.91½	10,097.73
5	Samuel Monroe, Phillip Kelly	1.40	6,406.40	1.50	13,761.00	1.50	16,599.00
6	Eichel, Arnold & Co			1.09	9,999.66	1.09	12,061.94
7	Josiah Thomas Hart			1.20	11,008.80	1.20	13,279.20
8	P. Halloran, F. W. Katterjohn, jr			1.19	10,917.06	1.24	13,721.84
9	L. Cramer & Son			1.19	10,917.06	1.19	13,168.54
10	William A. Kirk	1.20	5,491.20	1.22½	11,238.15	1.37½	15,215.75
11	L. Cramer & Son	1.50	6,864.00				
12	William D. Crammond			.94	8,623.56		
13	Du Pont Improvement Co			1.14	10,458.36	1.00	12,061.94

* Recommended for acceptance.

Abstract of proposals for furnishing towboat as tender to U. S. dredges Ohio and Oswego, received in response to advertisement dated March 8, 1895, and opened at Cincinnati, Ohio, April 13, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Price per day.	Remarks.
1	Ella Layman Towboat Co	$33.70	Boat has not sufficient power.
2	John J. Goodwin	35.00	
3	John F. Beaty	54.50	
4	Relief Towboat Co	37.50	
5	E. J. Hulings & H. B. Hulings	37.50	
6	Charles Hook, John Shoup	35.00	Recommended for acceptance.

ABSTRACT OF CONTRACTS.

Contractor.	Work of improvement.	Date of contract.	To expire.
Du Pont Improvement Co.	Earth for embankment at Shawneetown, Ill.	Dec. 21, 1894	Mar. 31, 1895.*
Hampton G. Grainger	Stone for embankment at Shawneetown, Ill.	Feb. 7, 1895	June 1, 1895.
Ed. J. Howard	Dump scow for United States dredges	Feb. 12, 1895	May 1, 1895.†
W. A. Kirk	Hire of dredging plant	Apr. 8, 1895	When discharged.
H. S. Brown	do	Apr. 10, 1895	Do.
Josiah Thomas Hart	Loose-stone dike at Blennerhassetts Island	Apr. 29, 1895	Aug. 15, 1895.
J. C. Thomas	Loose-stone dikes at Guyandotte Bar	Apr. 27, 1895	Do.
W. A. Kirk	Loose-stone dikes at Gunpowder Bar	Apr. 26, 1895	Do.
Patterson & Shipman	Loose-stone dikes at Flint Island	Apr. 29, 1895	Do.
Bedford, Weikel & Nugent.	Loose-stone dikes at Vanada Reef and Falls Slough Crossing.	Apr. 27, 1895	Do.
Do	Loose-stone dikes at Three Mile Island	do	Do.
Charles Hook and John Shoup.	Towboat for United States dredges	May 6, 1895	At close of season.

* Extended to May 15, 1895. † Extended to June 25, 1895.

MEDOC BAR.

[Extract from report of Mr. R. R. Jones.]

Medoc Bar is about 484½ miles below Pittsburg, being about 1½ miles above the mouth of the Big Miami River. For many years the bar has proved very troublesome to steamboatmen during low-water stages of the Ohio. Some thirty years ago a dike of loose stone was built out from the Kentucky shore, extending obliquely downstream and about 1,000 feet in length. The Kentucky shore at root of dike consists of soft material, loam, sand, etc., but a few hundred feet downstream the shores are steep and rocky. Opposite the dike on Ohio shore the banks consist of gravel, very firmly compacted and calculated to resist the scouring action of the river. At the old dike the river has a low-water width of about 1,500 feet, and the bed for one-third of the distance from Ohio shore is formed of gravel, the remaining distance to Kentucky shore being sand and loam.

The project for the improvement of channel at Medoc included the removal by dredging of about 200 linear feet of the old stone dike and the construction of a second dike 1,800 feet below the root of the old dike, to be built of loose stone.

Dredging.—Proposals for a dredge to be used in the removal of old dike were opened October 10, 1894, and the work awarded to the Campbell Creek Coal Company of Cincinnati, who were the only bidders. Flatboats for receiving the dredged material were secured, and on October 14 the dredge and flatboats were towed to Medoc where work was commenced on the following day (October 15). The work of unloading the flatboats and placing the stone in a dike head (at the point where the old dike was cut off) was done by hired labor, and at first some difficulty was experienced in obtaining a sufficient force of men to perform the work promptly. The water was quite low and but very light loads could be placed on the boats. The dredging was completed October 27, and the placing of the stone in dike head October 29. The dike head as built is 200 feet long, extending upstream from old dike, and is 24 feet wide at water level of 3.5 feet, Cincinnati gauge. The total quantity of material dredged and removed on flatboats was 1,224 cubic yards, of which 1,074 cubic yards of stone was placed in the dike head and outer end of old dike where low. The remaining 150 cubic yards, being mostly sand, was thrown off the flatboats just below and inside the line of new dike head.

New dike.—The contract for furnishing stone and constructing the new or lower dike was let to Hayman & Harrell, of Cincinnati, Ohio, under proposals received October 10, 1894. The contractors after bringing one lot of stone to the site of the dike, which stone did not comply with the requirements of the specifications, removed same and made no further effort to comply with the terms of their contract. It was then decided to construct at least a portion of the new dike from stone removed from the mouth of Licking River during the progress of that improvement. The work of building the new dike was commenced November 13, the stone being towed down the river from the excavation made by dredging at mouth of Licking River. From November 13 to December 10, 5,466 cubic yards of material was placed in the dike. Of this material from 72 to 75 per cent was stone, the remainder gravel. The finer particles were carried downstream, forming a flat slope on the downstream side of dike. Work was suspended December 10, the dike and dike head being then finished for the entire proposed length up to a level corresponding to about 3 feet on Cincinnati gauge. The dike is intended to be ultimately finished to the level of 6 feet on Cincinnati gauge. The small cost of the material justifies the excess in quantity as compared with quarried stone. Examinations made in December, 1894, and in June, 1895, indicate that the dike as far as completed is in good shape. The channel appears to have been much improved by the work already done. Thus far this season boats have had no trouble in passing the bar, although the water was quite low in June. Not only has the channel been deepened, but the sharp crossing has been materially modified, and the steamboat men express satisfaction in the results thus far obtained. A still greater improvement will undoubtedly follow the completion of the work.

DIKES AT FRENCH ISLAND.

[Extract from report of Mr. H. Devereux.]

The project for the improvement of the Ohio River at French Island contemplated the building of two spur dikes on the Kentucky side and one dam between the island and the Indiana side of the river and the removal of about 1,800 linear feet of an old dike built in 1832, which lay within the channel lines of the proposed improvement.

In compliance with your order I assumed local charge of the work as inspector.

The continued high water during the fall of 1893 prevented the contractor, William Kirk, of Madison, Ind., from completing the work on the dikes and the dam;

having secured an extension of time to November 30, 1894, operations were resumed August 1, 1894, and all the timber put in place on the two dikes and the dam during the following low-water season.

The top of the ties in the dam is at low-water mark and the top of the curbing at 1 foot above low water. The top of the curbing on No. 1 Dike follows the contour of the bar. The top of the curbing on No. 2 Dike was placed at 1 foot above low water. The ties in the heads of the dikes being unnecessary, were by your order omitted.

All piles were cut off with the tops of the curbing timbers. All sand and drift in both dikes and dam were removed before leveling the stone in the work. Several bad scours in the dam were stopped by using stone from the abutting shore protections. Sufficient stone having been placed in the dikes the previous season to finish them, the stone in No. 1 Dike was leveled and regularly placed to the tops of the curbing timbers, and is at an elevation of from 4 to 5 feet above low water; the stone in No. 2 Dike was placed according to the cross section, the crest being at an elevation of 4 feet above low water.

Rises in the river in October and November enabled the contractor to place enough stone in the dam and shore protections to finish them, the crest of the dam being at an elevation of 6 feet above low water.

DIKES AT SCUFFLETOWN, KY.

[Extract from report of Mr. C. A. Turrell.]

The original contract went into effect on June 20, 1893, and actual work was begun on September 2 and prosecuted to the end of the year. The work having been only one-third completed, a supplementary contract extended the time until November 30, 1894. Work was resumed on the 26th of May, and up to June 30, 1894, the work consisted entirely of placing smaller class of stone. The stage of water was too high to permit of placing curbing timbers, and the pile driver, which could have been used to advantage in April, did not arrive till July 18. The pile driving was completed August 23, the timber work August 30. The piles were sawed off and the placing of stone finished on December 18, under extension of time allowed contractors from November 30 to December 31, 1894.

The entire work was completed and contract finished according to specifications December 18, 1894.

The principal delays from June 30 to completion of contract were from the following causes:

	Days.
Waiting for pile driver	18
Low water	45
Disabled towboat	4

The low water of September and October, 1894, was extreme and long continued. The lowest reading on the Evansville gauge was 0.38 feet, equivalent to 0.28 feet above the standard of extreme low water on the gauge. Gauge readings at Scuffletown Bar during the working season form part of this report.

The quantities of material placed in dikes are given below.

* * * * * * *

Class of material.	Upper dike (length, 750 feet).			Lower dike (length, 1,530 feet).		
	Quantity.	Price.	Cost of material.	Quantity.	Price.	Cost of material.
Piles.....number..	178	$2.50	$445.00	347	$2.50	$867.50
Oak timber and plank.....feet, B. M..	19,560	20.00	391.20	40,790	20.00	815.80
Bolts, nuts, and washers.....pounds..	1,377	.05½	75.73	3,110	.05½	171.05
Spikes.....kegs of 150 pounds..	1	6.50	6.50	1	6.50	6.50
Excavation (root of dike).....cubic yards..	.....	.....	.....	143	.25	35.75
Stone, larger class.....do....	105	1.10	115.50	120	1.10	132.00
Stone, smaller class.....do....	3,298	0.94	3,100.12	5,165	.94	4,855.10
Total cost.....	.....	.....	4,134.05	.....	.....	6,883.70

Cost of material in 2 dikes, $11,017.75.

* * * * * * *

The general effect of the dikes on the channel has been to give an increased depth, so far as observed.

DREDGING AT THREE MILE ISLAND.

[Extract from report of Mr. H. Devereux.]

A cut 1,300 feet long, 35 feet wide, and to a depth of 4 feet below low water was made. One hundred and eighteen scow loads, at 42 cubic yards each, equal to 4,956 cubic yards of gravel, was removed and placed in a dump between the tow-head and Indiana bank, just below the foot of Three Mile Island, in nine and one-half working days, at a cost of 14.4 cents per cubic yard per working day.

DIKE AT MOUTH OF TRADEWATER RIVER.

[Extract from report of Mr. M. W. Venable.]

On June 28 I was directed by the engineer officer in charge of the Ohio River improvement to go to Caseyville, Ky., and make a survey of the river, beginning 1,000 feet above the dike then under construction and to extend the survey down to the lower end of the island, covering a distance of 3,900 feet. I reached Caseyville on the 29th p. m., and after arrival of instruments on the 2d of July, began the survey. Being unable to find any bench marks or reference by which a gauge could be reestablished, I set a temporary gauge 1,000 feet below the dike and began keeping a daily record of readings, in the meantime requesting the observer at Evansville, Ind., to send gauge readings from that point, after which zero of temporary gauge was set to correspond with zero of the gauge at Evansville. The fieldwork of survey was completed on the 14th of July. Old points on the base line run several years ago were found, and, as far as practicable, the old base line on the Illinois shore was reestablished from station 71 to station 110, from which Tradewater Bar and tow-head and the Kentucky shore were located by triangulation. Lines for soundings were established generally 290 feet apart, and soundings taken on these lines and levels run on the bars and shores, to establish contours on those portions not covered by water. After completion of fieldwork I was directed to go to Cincinnati and plot up notes. The results of this survey are embodied in a map on file in the Cincinnati office. On July 31 I was directed to return to Caseyville for the purpose of beginning operations on the dike, with instructions to have completed to grade that portion of the dike which was under construction last season. On August 2 the officer in charge of the river arrived at Caseyville and examined the condition of the work done last season, and also made an examination of the river below the dike and along the Kentucky shore back to Caseyville, when the contractor was notified to begin work.

The dike had been partially built during the past season, the piles being driven about 10 feet on centers on upper and lower side to a distance of 1,830 feet out into the river. These had been cut off about 4 feet above string timbers, and stone filling approximately to the grade then adopted was put in. During the winter floods some of the piles were taken out by drift and others displaced, and in two places the stone had been displaced, allowing deep, swift currents to pass through the dike, but with these exceptions the work was in a fair condition.

Timber.—Immediately on receiving notice to begin work the contractor proceeded to get out timber and stone, and commenced putting timber on dike on the 24th of August. The timber used was of the best quality of white oak, about half of it sawed and the remainder hewn; the sticks were 12 by 12 inches and generally 21 feet long, so as to provide a lap of 1 foot at each joint. It was placed on the inside of the line of piles above and below, so that the bottom of the sticks correspond with zero on the gauge established this season, and all bolted securely by 1-inch bolts to the piles. Wherever the irregularity in alignment of piles prevented a close fit to string timbers, packing blocks were inserted between pile and timber, and bolts drawn tight. At two points joints came where piles were missing; the timbers were reenforced by two pieces 4 by 12 inches by 20 feet long, bolted on each side of string timber and through the lap. The stage of water in river was generally favorable to the work, the top of the timber being out of the water most of the time. Considerable difficulty was encountered in putting on timber at the two points where the breaches were in the dike, on account of the depth of water and strong current.

The timber work was completed and piles sawed off to top of timbers by the 27th of September. The amount of timber put in was 44,240 feet, B. M.

Stonework was begun on September 5, and was continued to completion on November 27. The stage of the water was very low except for a few days in October, thereby making transportation of stone very slow. The quality of the stone used was good, especially the white pyriferous sandstone, which was mostly used. It was broken to "smaller size" as defined by specification, and filled into the top of timber

for 12 feet on lower half of the dike and crowning to 3 feet above timbers on the upper half. On the outer end of dike two boat loads of selected large stones were placed to resist the strong current more effectually. The total amount of stone put in the dike this season was 4,517.5 cubic yards.

Surveys and soundings.—The officer in charge of the improvements directed that as the work of filling the dike progressed, close watch be kept on the river below the dike by soundings and examinations, from time to time, to ascertain, if possible, the direction in which cutting was taking place. A survey was directed to be made of the gravel bar above the mouth of Tradewater River, with a view of ascertaining the feasibility of cutting a channel through it parallel with the Kentucky shore, and thereby straightening the low-water channel back of Tradewater Island and Bar. A survey was also made and all obstructions located by range stakes in the channel between Tradewater Bar and Kentucky shore, preparatory to removal of obstructions by snag boat.

The results of all examinations and surveys were returned to the Cincinnati office, except the examination made on November 27–28, which is returned with this report.

Work done (not by contract).—As the low stage of water was exceedingly favorable, the officer in charge directed the employment of teams and scrapers and the excavation of a channel as deep as practicable through the gravel bar above the mouth of Tradewater. On the 20th of October work was begun, and completed on November 7, excavating 11,094 cubic yards from a channel 125 feet wide and to zero of the gauge, depositing the material along the Kentucky shore. Also 1,338 yards was taken off the shoulder of the main bar opposite the mouth of Tradewater, thereby straightening the channel on that side. The material excavated from gravel bar was gravel from the size of pease to filberts, mixed with coarse sand; on the main bar it was gravel and sand mixed. A pile of stone on main bar was also removed and placed on the Kentucky shore immediately below the mouth of Tradewater.

Gauge.—A temporary gauge was established on arrival at the site of work by comparison with daily readings of gauge at Evansville. After it was established the readings were recorded, taken from this gauge, until August 22, when by correspondence with Mr. Innes, the former inspector, the bench mark was found to which his datum plane of last season was referred, on comparing which with the one I had established it was found that the zero of last season was 0.4′ lower than that set the present season. After a study of hydrographs for July of gauges at Evansville, Shawneetown, and temporary gauge at Caseyville, the engineer officer in charge directed that a permanent gauge be established with datum plane 1 foot higher than the one used last season, and that the dike be built from it as a reference. All gauge reports since August 22 are taken from this gauge. This new gauge was placed near the Government light on the Kentucky shore, 1 mile below Caseyville. The gauge is set parallel with the slope of the bank and is made of cypress timber, 1 by 4 inches, painted with two coats of white lead and oil, divided to feet and tenths, the feet marked by Roman and tenths by Arabic numerals, countersunk into the wood by branding, and painted black. The gauge reads 17 feet, and is securely spiked to an oak sill 4 by 6 inches by 46 feet long, set on edge, and this bolted to posts 4 by 6 inches by 4 feet, about 7 feet on centers, anchored in the ground, so as to bring the top of gauge about 6 inches above the surface of slope. The lower end is drift bolted to a heavy oak log 12 by 12 inches by 8 feet, lying up and down stream and held down by stone piled over it.

Bench marks were established near the gauge, one on a pecan tree, 26.75 feet above zero of gauge, one on a large cottonwood, 30.16 feet above zero of gauge, and one on a nail in Government lamp-post, 32 feet above zero of gauge.

The snag boat *E. A. Woodruff* reached Caseyville in the evening of the 22d of November and began work in the Tradewater channel next day, working until the 30th, and removing all obstructions that had been referenced which it could reach at that stage of the water, except the large bowlder near lower end of towhead, on which some blasting was done.

Work on the dike was completed on November 27. Survey of the channel above and below the dike was made on the 27th and 28th, when operations were closed for the season, instruments and tools were shipped to the Cincinnati office, and on receipt of instructions on December 1, I returned to Cincinnati.

DIKES AT MOUND CITY, ILL.

[Extract from report of Mr. A. F. Spreen.]

A survey covering 1¼ miles of river was begun on September 10, and finished October 12. Some of the points in the survey made in 1887 were found and relocated, so that close comparison of the two surveys can be made. Carefully marked stones were planted at all the triangulated points of the survey.

Dredging was begun on September 26 in patch C, and 5 parallel and adjacent cuts, each 600 feet in length, were completed on October 19. About 8,738 yards of coarse gravel was removed and deposited immediately below the upper dike. On October 20 the work of dredging two cuts on line A–B, each about 2,600 feet in length, was begun, and finished on November 22. About 15,990 yards of sand and gravel was removed and deposited on line M–N. Dredging was then commenced in patch D. Here a tough clay and cemented gravel and rock were found, and the cuts could only be carried about 200 feet when the overlying conglomerate crust became too heavy for the dredge to break. About 4,510 yards was removed and deposited on line K–L. The dredge was then again removed to line A–B on December 12, and a third cut about 900 feet in length was made, when operations ceased on December 18, on account of high water. About 2,530 yards of sand and fine gravel was removed and deposited on line K–L. Dredging was carried to 4 feet below low-water mark (zero of the gauge), excepting in the upper end of line A–B, where a hard conglomerate was found to rise from 1 to 3 feet above grade for a distance of 600 feet, more or less. A great number of borings were made to define the depth and extent of this formation.

Current observations were also made to determine its direction from patch C to the pool below the bar. From soundings made on December 20 it was found that the long cuts on line A–B had widened out 200 feet, or more, toward the Illinois shore, and the direction of the current indicates a still greater increase both in depth and width. A slight fill is perceptible, however, just below the hard formation found in the upper end of the cut.

During the season 60 yards of large stone was placed around the dike head, and 624.4 yards of small stone placed in the low places in the lower dike. All the stone in both dikes was leveled down to a 4-foot stage, and all piles cut off at that elevation. The river did not reach a low enough stage to allow of the stones being placed in the cross section desired, but the effective work of the dikes will not be materially lessened on this account.

The dikes being now closed up, and having noted the widening of dredge cuts and the favorable direction of the current, the indications are that the work of the season will be beneficial and lasting, and that navigation here during the next low-water season will be better than it has been for years past.

WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1894.

[Extract from the report of Mr. E. J. Carpenter.]

The dredging fleet remained in winter quarters at the mouth of Kentucky River until April 26, when the boats were taken to Cincinnati for repairs.

As it was desirable to begin operations at the Clusters early, so that as much of the work as possible might be completed before the low-water season began, the usual thorough annual repairs were omitted and only such repairs made as would temporarily fit the boats for resumption of work.

The fleet left Cincinnati on May 8, and on the 14th reached the Clusters, where dredging was begun at once.

In September and October it was found necessary to stop the dredges to repair the cranes and dippers, which had been damaged and worn by the hard excavation at the Clusters, and to calk the dump scows, one boat at a time being laid off while the other remained at work.

Dredging was twice interrupted by high water and the passage of coal tows, at the Clusters, May 20 to 27, and at Brunots Island, September 20 to 23. But one day was lost from low water, because the boats were at work in the Pittsburg Harbor pool during almost the entire low-water season.

On completion of the season's work the dredging fleet was laid up for the winter at Marietta, Ohio, in the mouth of Muskingum River.

Clusters (*52.5 miles below Pittsburg*).—Dredging at this point was for the purpose of removing a gravel bar on the left, which lay within the lines of the proposed new channel, the material being too hard for removal by scour from the dikes which were in process of construction.

The dredging was continued until June 29, when the river having become so low that the boats could no longer work to advantage they were moved to Brunots Island, in the pool above Davis Island Dam, where operations could be continued through the low-water season.

When the river rose in November the dredges returned and completed the work, also cutting off the shore bar at Brimstone Run, opposite the foot of the lower island.

The Clusters Bar, the upper part of which consisted of cemented gravel, was dredged for a length of 2,600 feet, the channel being widened 215 feet at the point of greatest danger to tows.

Excavation made May 14 to June 29, November 12 to 28:		
Cemented gravel, etc	cubic yards..	30,711
Gravel and bowlders	do....	22,361
Total	do....	53,072
Rocks removed (8)	tons..	28.6

Brimstone Run Bar, Ohio (53 miles below Pittsburg).—This point of loose rock, gravel, and clay, on which a number of coal barges had been wrecked, was almost entirely removed, the channel being widened 125 feet, and also materially straightened. Some additional work there might be done to advantage, but there is now little danger of further loss to tows.

Excavation made November 21 to 28:		
Loose rock, gravel, etc	cubic yards..	5,007
Rocks removed (1)	tons..	14.85

Head of Brunots Island (1.6 miles below Pittsburg).—During almost the entire low-water season, which was unusually long, the dredges were employed to widen and straighten the channel past Brunots Island, where a large number of coal boats and barges had been wrecked. The channel, which had been growing worse for the past twelve or fifteen years, had become one of the most dangerous that tows had to run, and but for the fact that boats usually ran it with half a tow or less, and that its proximity to Pittsburg made it possible to have the temporary help of an extra boat, the loss would probably have been greater than at any other place.

The principal reason for the bad condition of the channel is the washing away of the head of the island, giving passage to a large body of water that does not go through the channel, and the destruction by ice of the riprap dam across the back river at Chartiers Creek.

A great improvement was made by the dredging, but it will not be permanent unless a dike is built to confine the water to the channel and stop cutting away the head of the island.

The bar at the head of the island was dredged for a distance of over 3,400 feet, the channel being widened 200 feet at the point where tows had the greatest difficulty.

Excavation made July 3 to October 13:		
Gravel	cubic yards..	88,723
Loose rock and gravel	do....	6,660
Snags removed (1)	tons..	0.4

Foot of Brunots Island (2.7 miles below Pittsburg).—A straight channel was made for tows by cutting through the high gravel bar on the right, thus obviating the necessity of crossing to the foot of the island. Owing to the location of the Philadelphia Company's gas pipes, two 10-inch lines of which cross from the island to the Allegheny bank along the upper edge of the bar, it was impossible to begin dredging high enough upstream to give sufficient depth for tows drawing all the water indicated on the Pittsburg marks, and on this account the old channel close to the foot of the island was left open.

The dredging increased the width of the channel 240 feet for tows drawing about 14 inches less than shown on the Pittsburg marks.

Excavation made September 17 to November 10:		
Gravel and bowlders	cubic yards..	23,095
Wreck removed (coal boat bottom)		1
Rocks removed (4)	tons..	6.1
Snags removed (1)	do....	1.8

Davis Island Dam (4.5 miles below Pittsburg).—Two wrecked barges which had been sunk at the upper entrance to the lock were broken up and removed September 26–27.

Logstown Bar (17.6 miles below Pittsburg).—The remains of an old dike which lay in the line of the new channel, preventing the bar from being scoured away by the new dike, was dredged out. An attempt to remove the obstruction in September was interrupted by low water, but at a second trial, during November, the whole of the old dike was dredged out.

The bar on each side of the dike was found to be of coarse gravel, extremely hard.

Excavation made September 25 and November 7 to 9, loose rock and gravel, cubic yards 1,946

Horsetail Ripple (5 miles below Pittsburg).—Wrecks removed November 6: 1 coal barge, 1 piece steamboat hull.

Mouth of Muskingum River (171 miles below Pittsburg.)—It was found necessary to widen the channel at mouth of the Muskingum in order to have room for the dredges in winter quarters.

Excavation made December 1 to 5:

Mud, etc	cubic yards..	2,595
Snags removed (3)	tons..	6.6

OHIO RIVER DREDGING STATEMENT FOR 1894.

DREDGES IN COMMISSION.

TIME.

	Time at work.		Time lost.
	Days.		*Days.*
Dredging loose rock, cemented gravel, etc	52.1	Sundays	30
Dredging gravel, mud, etc	51.1	Accidents	40.1
Removing logs and snags	.3	Stopped for repairs	12
Removing rocks	.7	Traveling	8
Removing wrecks	1.2	High and low water	8.7
		Fog	.8
		Holidays	4
Total	105.4	Total	103.6

Total in commission, 209 days.

WORK.

	Per day of work.	During the season.
	Cu. yds.	*Cu. yds.*
Loose rock, cemented gravel, etc., excavated	1,627.1	84,773
Gravel, mud, etc., excavated	1,885	96,325
Total excavation for the season	.....	181,098

	Number.	Tons.
Logs and snags removed	5	8.8
Rocks removed	13	49.6
Wrecks removed	5	.....

COST.

	Per day in commission.	Per day of work.	For the season.
Equipment	$5.80	$11.50	$1,211.79
Towing and fuel	37.81	74.99	7,908.60
Repairs	7.32	14.51	1,528.89
Salaries	48.96	97.08	10,232.36
Total cost	99.89	198.44	20,876.64

DREDGES OUT OF COMMISSION.

TIME.

	Days.
In ordinary	144
Annual repairs	12
Total	156

COST.

Salaries in ordinary	$1,820.07	
Towing, fuel, and other expenses	275.94	
Total in ordinary		$2,096.01
Salaries during annual repairs	1,095.97	
Annual repairs (shop bills, materials, etc.)	408.02	
Total cost of repairs		1,503.99
Total out of commission		3,600.00
Cost per day in ordinary (including superintendent's pay)		14.56

COST OF WORK, INCLUDING ALL EXPENDITURES IN 1894.

Dredging loose rock, cemented gravel, etc	$12,098.98
Dredging gravel, mud, etc	11,866.76
Removing logs and snags	69.66
Removing rocks	162.56
Removing wrecks	278.67
Total expenditure in 1894	24,476.63

COST PER UNIT.

Per cubic yard of loose rock, cemented gravel, etc., excavated	$0.143
Per cubic yard of gravel, mud, etc., excavated	.123
Per day in commission	117.12
Per day of work	232.23

The *day of work* is for ten hours actual operations of the two dredges with four dump scows and one towboat for tender, after taking out every hour lost by accident or otherwise.

The towboat *John C. Fisher*, chartered as dredge tender, was paid $37.50 per day, this amount covering the cost of the boat with outfit, crew and fuel for the towboat and dredges; except that all cost of coal in excess of 5 cents per bushel was repaid by the Government.

The total expenditure includes all outlay in 1894 properly applicable to the cost of dredging.

Location and description of work.

Place.	From Pittsburg.	Date.	Days of work.	Kind of work.	Logs and snags.		Rocks.		Wrecks.
					No.	Tons.	No.	Tons.	
	Miles.	1894.							
Clusters, upper end of bar.	52.5	May to November.	18.9	Dredging cemented gravel and bowlders.	....	.....	....	.....	.....
Do	52.5	June to November.	.3	Removing rocks	....	.....	8	28.6	.....
Clusters, lower end of bar.	52.5	May to November.	13.5	Dredging hard gravel and bowlders.	....	.....	....	.....	.....
Head of Brunots Island.	1.6	July to October.	46.9	Dredging soft gravel.	....	.....	....	.....	.....
Do	1.6	August to October.	4.3	Dredging loose rock and gravel.	....	.....	....	.....	.....
Do	1.6	September	.1	Removing snag	1	0.4	....	.....	.....
Foot of Brunots Island.	2.7	September to November.	14.2	Dredging hard gravel and bowlders.	....	.....	....	.....	.....
Do	2.7	October	.1	Removing snag	1	1.8	....	.....	.....
Do	2.7	.....do	.1	Removing rocks	....	.....	4	6.1	.....
Do	2.7	October to November.	.1	Removing wreck	....	.....	....	.....	1
Logstown Bar	17.6	September to November.	1.2	Dredging loose rock and gravel.	....	.....	....	.....	.....
Davis Island Dam	4.5	September	.9	Removing wrecks	....	.....	....	.....	2
Horsetail Ripple	5	November	.2	.....do	....	.....	....	.....	2
Brimstone Run Bar.	53	.....do	2.8	Dredging loose rock, clay, and gravel.	....	.....	....	.....	.....
Do	53	.....do	.8	Removing rock	....	.....	1	14.9	.....
Mouth of Muskingum River.	171	December	1.4	Dredging mud	....	.....	....	.....	.....
Do	171	.....do	.1	Removing logs	3	6.6	....	.....	.....
Total	.....	.....	105.4	.....	5	8.8	13	49.6	5

Location and description of work—Continued.

Place.	Excavation.				Expenditures.					
	Loose rock, cemented gravel, etc.	Gravel, mud, etc.	Per day of work.	Cost per cubic yard.	Removing logs and snags.	Removing rocks.	Removing wrecks.	Dredging loose rock, cemented gravel, etc.	Dredging gravel, mud, etc.	Total for 1894.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*							
Clusters, upper end of bar	30,711		1,624.9	$0.143				$4,389.08		$4,389.08
Do						$69.67				69.67
Clusters, lower end of bar	22,361		1,656.4	.14				3,135.05		3,135.05
Head of Brunots Island		88,723	1,891.7	.123					$10,891.41	10,891.41
Do	6,660		1,548.8	.15				998.57		998.57
Do					$23.22					23.22
Foot of Brunots Island	23,095		1,626.4	.142				3,297.61		3,297.61
Do					23.22					23.22
Do						23.22				23.22
Do							$23.22			23.22
Logstown bar	1,946		1,621.7	.144				278.67		278.67
Davis Island Dam							209.00			209.00
Horsetail Ripple							46.45			46.45
Brimstone Run Bar		5,007	1,788.2	.129					650.23	650.23
Do						69.67				69.67
Mouth of Muskingum River		2,595	1,853.6	.125					325.12	325.12
Do					23.22					23.22
Total	84,773	96,325			69.66	162.56	278.67	12,098.98	11,866.76	24,476.63

ADDITIONAL OPERATIONS OF U. S. DREDGES.

[Extract from report of Mr. E. J. Carpenter.]

The necessary repairs to the dredging machinery and the dump scows were made April 4 to May 15, 1895, at Marietta, Ohio, where the fleet had spent the winter.

The *Oswego*, which was ready for work a few days ahead of the *Ohio*, was there employed to widen the entrance to the Muskingum River, after which the work of the season was continued without interruption until June 24, when the river having become so low that both dredges could no longer be kept busy, the *Ohio* was stopped and her crew employed in removing dangerous rocks from the channel.

The work accomplished is as follows:

Marietta, Ohio (*171 miles below Pittsburg*).—The gravel bar at the mouth of Muskingum River was dredged off, widening the channel 75 feet, which makes it possible for boats to enter the river without getting aground.

Excavation made, May 13–14, soft gravel, 1,230 cubic yards.

Foot of Blennerhassetts Island (*188.5 miles below Pittsburg*).—Dredging at this point was for the purpose of opening a channel below the towhead, at the gravel reef which previously interrupted navigation before the river fell to a low-water stage. A channel with 100 feet minimum width was made, which has satisfactorily answered its purpose, and there seems little doubt that the new dike will keep it open.

Excavation made, May 16–25, soft gravel, 11,680 cubic yards. May 17, 1 log, 0.3 tons.

Head of Vienna Island (*176.5 miles below Pittsburg*).—A coal barge sunk in the channel and abandoned by the owners was broken up and removed by the dredge *Ohio*, May 20.

Guyandotte Bar (*303 miles below Pittsburg*).—After completion of the work at Blennerhassetts Island the dredges were brought to this place, where they have since been employed. The most dangerous part of the upper bar, consisting of very hard gravel and bowlders, with many large rocks, has been dredged off, and with it the old riprap dike built in 1855 by the citizens of Guyandotte for the purpose of deepening the channel at their wharf.

A considerable portion of the bar on the West Virginia shore below the mouth of Guyandotte River has also been dredged off, making the new channel for tows 570 feet wide, and this work is being continued. A great number of large rocks, most of which bear marks showing that they have been struck by boats, have been removed from the channel opposite and above Guyandotte. This work is also in progress.

Excavation made: Upper Bar, opposite wharf, May 27 to June 4, loose rock, bowlders and cemented gravel, 3,649 cubic yards. Large rocks removed, 192, weighing 84.1 tons. Shore Bar, below Guyandotte River, June 4–29, gravel and bowlders, 18,927 cubic yards. Large rocks removed, 12, weighing 11.2 tons. Logs removed, 2, weighing 0.9 ton.

Coal shipments from Pittsburg, Pa.

[Furnished by Capt. William Evans.]

Months.	To Cincinnati.					To Louisville.				
	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.
1894.										
January	21	12	253	.....	132,304	21	55	194	.....	144,047
February	26	38	298	.....	187,524	30	196	116	4	241,504
March	28	80	277	1	281,383	34	185	214	22	281,383
April	21	33	212	.....	129,771	27	116	238	11	229,394
September	27	13	358	.....	183,280	16	9	217	12	114,317
October	2	.....	24	.....	11,363	.....	.....	.....	.....	.....
December	33	28	428	.....	228,140	36	207	250	33	289,377
Total	158	204	1,850	1	1,153,765	164	768	1,229	82	1,300,022
Grand total	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,453,787

Comparative table showing coal shipments from Pittsburg during the ten years ending December 31, 1894.

Year.	To Cincinnati.	To Louisville.	Total.	Year.	To Cincinnati.	To Louisville.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1885	1,733,104	1,114,008	2,847,112	1890	1,324,641	2,095,716	3,420,357
1886	1,262,702	2,220,530	3,483,232	1891	1,065,705	1,828,047	2,893,752
1887	788,690	1,367,012	2,155,702	1892	914,430	1,384,864	2,299,294
1888	1,950,882	2,223,494	4,174,376	1893	829,878	1,534,523	2,364,401
1889	1,149,892	1,439,747	2,589,639	1894	1,153,765	1,300,022	2,453,787

Commerce passing Davis Island Dam in 1894.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.		Through pass.		Through lock.		Through pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	63	2,241	276	18,675	66	3,161	269	29,517	53,594
Towboats	198	.....	1,056	.....	148	.....	1,124	.....	.....
Model barges	6	.....	37	.....	.....	.....	60	42,128	42,128
Coal boats	154	.....	344	.....	.....	.....	1,225	1,109,512	1,109,512
Barges	577	.....	2,502	9,224	54	12,905	2,971	1,554,117	1,576,246
Flats	301	3,895	961	11,679	177	16,469	1,243	181,450	213,493
Rafts	.....	.....	1	500	5	1,437	38	148,698	150,635
Miscellaneous	35	.....	84	200	56	.....	89	.....	200
Total	1,334	6,136	5,261	40,278	506	33,972	7,019	3,065,417	3,145,803

Commerce passing the site of the Movable Dam No. 6, Ohio River, in 1894

Vessels.	Ascending.		Descending.	
	No.	Freight.	No.	Freight.
		Tons.		*Tons.*
Packets	325	35,000	314	33,800
Towboats	883	.....	871	.....
Model barges	43	.....	60	57,000
Coal boats	498	.....	1,225	1,117,200
Barges	3,079	.....	3,025	1,609,300
Flats	1,262	.....	1,220	185,440
Rafts	.....	.....	22	66,000
Total	6,090	35,000	6,737	3,068,740

Highest, lowest, and average stages of the Ohio River at Cincinnati, etc.—Continued.

Calendar year.	Highest stage.		Lowest stage.		Average for the year.
	Date.	Stage.	Date.	Stage.	
1878	Dec. 15	41 4	Oct. 24	4 4	16 9
1879	Dec. 27	42 9	Oct. 23	2 6	14 6
1880	Feb. 17	53 2	Oct. 28	3 9	17
1881	Feb. 16	50 7	Sept. 18	1 11	16 11
1882	Feb. 21	58 7	Nov. 1	6 1	*22 1½
1883	Feb. 15	†66 4	Sept. 21	3 7	*19 5½
1884	Feb. 14	‡71 0½	....do	2 9	*17 4
1885	Jan. 20	46	Sept. 26	2 6	*15 7
1886	Apr. 9	55 9	Nov. 1	3 4	*17 10
1887	Feb. 5	56 3	Sept. 23	2 8	*15 1½
1888	Apr. 1	39 11	Aug. 7	5 3	*17 11
1889	Feb. 22	38 3	Sept. 13	5 3	*18 6
1890	Mar. 26	59 2	Aug. 30	5 9	*25 8
1891	Feb. 25	57 4	Oct. 7	4 5	*20 6
1892	Apr. 25	43 8	Nov. 5	3 5	*16 6
1893	Feb. 20	54 11	Aug. 30	3 7	*17 8
1894	Feb. 15	35 6	Sept. 9	3 1	*12 9

* Prepared from the stages as shown by the waterworks marks daily at 6 a. m. and 6 p. m., the previous years having been made from one daily observation at 6 a. m.
† 4 o'clock to 5 o'clock a. m., inclusive.
‡ 12 o'clock noon to 1.30 p. m.

Schedule of rates on flour per barrel by rail and river from Cincinnati for nine years ending December 31, 1894.

Year.	To Pittsburg.		To Louisville.		To New Orleans.		To Memphis.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1886	26–31	15–20	15	15	44	35–39	.....	.....
1887	24–31	15	15	15	44–49	35	.....	.....
1888	22–24	15	15	15	40–49	35	.....	.....
1889	23	15	15	15	54	55	.....	.....
1890	23–24	15	15	15	49–54	35	.....	.....
1891	24	15	15	15	49	35	.....	.....
1892	24	15	15	15	49	35	40	30
1893	24	15–20	15	15–10	49	35–30	40	30–40
1894	24	20	15	10	49	40	40	30

Comparative statement of commerce passing the falls of the Ohio River by canal and by river.

Year.	Canal.		Open river.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1882	3,988	935,628	2,305	668,866	6,293	1,604,494
1883	5,231	1,349,115	1,484	483,281	6,715	1,832,396
1884	3,485	785,192	1,548	484,124	5,033	1,269,316
1885	5,678	1,443,181	822	262,862	6,500	1,706,043
1886	4,964	1,240,112	1,796	577,547	6,760	1,817,659
1887	4,069	867,807	2,297	1,204,518	6,366	2,072,325
1888	6,963	1,915,365	2,252	1,162,305	9,215	3,077,670
1889	5,534	1,404,573	1,984	957,829	7,518	2,362,402
1890	4,386	998,062	3,928	1,717,158	8,214	2,715,220
1891	4,739	1,302,471	2,137	1,062,428	6,876	2,364,899
1892	5,506	1,275,329	1,826	858,953	7,332	2,134,282
1893	3,902	848,211	1,722	514,317	5,624	1,362,528
1894	5,280	1,245,899	461	149,937	5,741	1,395,836

Commerce of Ohio River in 1894.

Name of boat or company.	Between what points on the Ohio River.	Distance on Ohio River.	Months in commission.	Freight.	Number of passengers.
		Miles.		*Tons.*	
Coal shipments from Pittsburg.	Pittsburg to Cairo	965	7	2,453,786	
Gray's Iron Line	do	965	7	15,811	
Huntington and St. Louis Towboat Co.	do	965	9	86,596	
John Barrett & Son	do	965	8	205,000	
A. Montgomery & Co	Pittsburg to Louisville	599	9½	349,888	
Steamer H. K. Bedford	do	599	11	12,944	3,947
Relief Towboat Co	do	599	8	300,000	
Steamer Ida Budd	Pittsburg to Cincinnati	467	12	111,360	
Steamer Elaine	do	467	12	18,712	
Steamer Eliza H	do	467	10	24,402	
Hulings Bros	do	467	8	15,468	
Steamer Adelle	do	467	4	57,114	
Steamer Hawk	do	467	5	32,012	
Steamer Iron Queen	do	467	6½	18,310	5,829
Steamer Keystone State	do	467	7	18,600	6,200
Steamer Hudson	do	467	7	15,893	3,712
Steamer Jim McConnell	Pittsburg to Portsmouth	370	5	25,550	
Steamer Lizzie Bay	Pittsburg to Gallipolis	265	8	3,700	4,300
Steamer Belle Prince	Pittsburg to Parkersburg	183	4	3,000	
Steamer Ben Hur	do	183	7	6,872	16,772
Steamer Courier	do	183	9	7,296	7,595
Steamer C. W. Batchelor	Pittsburg excursions		4	500	12,000
Steamer C. C. Martin	East Liverpool to Louisville	587	8	1,600	902
Thomas J. Hall	Wheeling to New Albany	527	7	39,918	
Steamer Ida Smith	Wheeling to Gallipolis	200	6	500	2,400
Steamer R. E. Phillips	Wheeling to Matamoras	54	8	4,270	12,457
Steamer Liberty	Wheeling to Clarington	28	8	2,400	5,543
Steamer T. N. Barnsdall	Matamoras to Marietta	32	9	3,240	10,800
Steamer Columbia	Marietta to Gallipolis	96	7	5,945	2,775
Steamer Lyde H	Marietta to Long Bottom	36	3	1,013	2,046
Steamer Valley Belle	Long Bottom to Middleport	39	7	10,600	4,260
Syracuse Coal and Salt Co	Syracuse to Cincinnati	224	9	14,880	
The Jessie Towboat Co	do	224	6	600	
Steamer C. A. Hill	Syracuse to Gallipolis	24	6	5,400	6,167
Steamer Wm. Wormald	New Haven to Cincinnati	224	8	12,227	
Steamer Nancy	Pomeroy to Portsmouth	110	4	842	2,760
Pomeroy and Cincinnati Packet Co.	Pomeroy to Cincinnati	219	9	125,276	32,955
John Taylor & Sons	Middleport to Louisville	350	6	25,000	
Ella Layman Towboat Co	Point Pleasant to Louisville	335	6	90,920	
Steamer Sea Lion	do	335	7	200,000	
Steamer Buckeye Boy	do	335	6	183,000	
Steamer F. J. O'Connell	do	335	9	66,363	
The Marmet Co	do	335	9	119,788	
Ironton Cross-tie Co	Point Pleasant to Cincinnati	203	10	18,750	
Pomeroy, Cincinnati and Louisville Barge Line.	do	203	7	200,000	
Steamer Crown Hill	do	203	8	80,000	
Armstrong Bros	do	203	4	120,000	
Kanawha and Ohio Transportation Co.	do	203	6	104,425	
Steamer Henry M. Stanley	do	203	10	24,320	6,471
Galbreath & Bushman	do	203	8	15,238	
Steamer Coal Bluff	do	203	3	67,535	
Steamer Claribel	Point Pleasant to Gallipolis	4	8	4,541	6,775
Steamer Carrie Brown	Gallipolis to Huntington	39	8	2,750	9,174
Steamer Vesper	do	39	8	3,200	13,500
Steamer Favorite	do	39	4	2,300	1,600
Steamer Chevalier	Proctorville to Portsmouth	51	8½	4,900	7,000
Little Kanawha Lumber Co	Guyandotte to Portsmouth	50	4	420,000	
Steamer Tom Spurlock	Big Sandy to Portsmouth	40	4	280,000	
Steamer Ruth	Huntington to Portsmouth	47	6	1,415	10,735
Steamer Georgia	Huntington to Ironton	18½	3	125	5,640
Steamer J. H. McConnell	Catlettsburg to Ironton	10	10	200,000	
Ashland Coal and Iron Rwy Co.	Ashland to Portsmouth	33½	8	5,940	
Steamer Jerrie	Ashland to Ironton	5	6	50	12,000
Steamer Lee H. Brooks	Ironton excursions		6	275	4,499
Zuhars Bros	Hanging Rock to Louisville	271	9	6,616	
Steamer Henrietta	Portsmouth to Louisville	244	8		4,225
Steamer Reliance	Portsmouth to Rome	27	10	1,850	1,160
James R. Ware	Concord to Lawrenceburg	102	12	6,200	
Buena Vista Freestone Co	Buena Vista to Cincinnati	95½	10	19,600	
John A. Borches	Manchester to Warsaw	130	11	8,000	
Steamer Enos Taylor	Maysville to Augusta	19½	6	400	2,000
John Trapp	Beasley Creek to Cincinnati	54	2½	7,563	
Steamer Tacoma	Chilo to Cincinnati	35	9	9,720	7,200

Commerce of Ohio River in 1894—Continued.

Name of boat or company.	Between what points on the Ohio River.	Distance on Ohio River.	Months in commission.	Freight.	Number of passengers.
Steamer Rob Roy	New Richmond to Cincinnati	20	9	75,700	.....
Steamer Alice L. Barr	New Richmond to Aurora	47	12	145,000	.....
The Coney Island Co	Coney Island to Cincinnati	10	3	500	278,938
Henry Spillie & Son	Dayton to Cincinnati	3	8	10,000	.....
Smith Coal and Sand Co	....do	3	12	120,000	.....
R. H. Fleming	Newport to Ludlow	2	12	15,700	.....
Memphis and Cincinnati Packet Co.	Cincinnati to Cairo	499	8	146,639	27,645
Cincinnati and Louisville Packet Co.	Cincinnati to Louisville	132	12	157,350	79,183
Steamer B. S. Rhea	Cincinnati to Madison	86½	8	2,145	1,389
Steamer Ghent	....do	74½	10	2,200	980
James Tucker	Cincinnati to Big Bone	46	10	4,000	.....
Steamer Levi J. Workum	Cincinnati to Petersburg	25	12	6,567	1,104
Steamer Jim Montgomery	Warsaw to Lawrenceburg	35	4	120	250
Steamer Swan	Aurora to Rising Sun	10	12	300	1,200
Steamer Hattie Brown	Warsaw to Madison	29	12	4,263	15,962
Steamer Little Sandy	Carrollton to Madison	12	9	1,680	2,863
Steamer Falls City	Carrollton to Louisville	57	10½	10,500	6,941
Steamer Rescue	....do	57	7	7,840	2,878
Louisville and Jeffersonville Ferry Co.	Excursions	.....	4	.....	153,474
Steamer D. A. Nisbet	Louisville to Cairo	367	10	16,840	16,892
Steamer Racket	....do	367	11	45,000	50
Louisville and Evansville Mail Line Co.	Louisville to Henderson	197	11	99,319	29,674
Steamer Plucky City	Louisville to Evansville	185	7	105,000	.....
Steamer Little Albert	....do	185	10	3,236	.....
Steamer Henry Logan	Louisville to Derby	88	4	1,338	90
Steamer G. B. Monteith	Hawesville to Owensboro	32	4	11,500	.....
Steamer Judelle	Cannelton to Owensboro	32	12	5,673	15,785
Steamer Stoneware	....do	32	3	950	1,080
Steamer Rosedale	Owensboro to Cairo	216	6	3,065	3,130
Steamer Jewel	Owensboro to Henderson	45½	12	8,977	45,066
Steamer Royal	....do	45½	8	7,144	18,936
Steamer Herbert Moran	Mouth Green River to Evansville.	8	7	23	876
John Ingle & Co	....do	8	6	214,000	.....
Steamer Little Clyde	....do	8	5	1,440	.....
Steamer Mary Stuart	....do	8	12	907	780
Steamer T. C. Woodward	....do	8	9	45	1,675
M. L. Saurheber	Evansville and vicinity	.....	10	1,440	.....
Steamer I. N. Hook	Evansville to Cairo	182	1	750	.....
Evansville, Paducah and Tennessee River Packet Co.	Evansville to Paducah	137	12	20,800	1,100
Steamer John S. Hopkins	....do	137	12	13,800	11,468
Steamer Joe Fowler	....do	137	11	10,089	9,817
Steamer D. A. Brooks	....do	137	12	2,525	280
Steamer Lancaster	Elizabethtown to Paducah	43	6½	3,500	3,625
Steamer W. K. Phillips	Evansville to Smithland	125	6	5,750	645
Steamer Clayton H. Webb	Shawneetown to Cairo	117	2	1,000	.....
Steamer Maggie Belle	....do	117	6	35,000	.....
Steamer Dick Clyde	Saline River to Brooklyn	66	6	35,500	.....
Steamer Emma Cooper	Saline River to Paducah	63	10	3,211	.....
Steamer Corinne No. 2	Golconda to Cairo	75	6	13,465	71
Nashville and Paducah Packet Co.	Smithland to Paducah	12	10	8,627	2,045
Steamer Albert S. Willis	Paducah to Cairo	45	7	25,044	.....
St. Louis and Tennessee River Packet Co.	....do	45	10	58,880	6,410
Steamer Dick Fowler	....do	45	12	6,340	29,000
Steamer City of Metropolis	Paducah to Metropolis	9	12	2,500	25,800
Steamer Fannie	....do	9	1	10	840
Total	.....	.....	.....	7,795,501	1,033,492

C C 2.

OPERATING SNAG BOAT ON OHIO RIVER.

The river and harbor act of September 19, 1890, contained the following item:

SEC. 13. That for the purpose of securing the uninterrupted work of operating snag boats on the Ohio River, and removing snags, wrecks, and other obstructions in said river, the Secretary of War, upon the application of the Chief of Engineers, is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of twenty-five thousand dollars: *Provided, however*, That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The object of the above provision was undoubtedly to provide funds for the constant operating of the snag boat in the most efficient manner, without subjecting her important service to the uncertainties arising from the failure of yearly appropriations. The provision is one of great importance to the navigation interests of the Ohio River, and the work of the snag boat in removing snags and wrecks has done much toward increasing the safety and ease of navigation. The amount of $25,000 per year, which is authorized to be expended for this service, is not sufficient to keep the boat employed for the length of time that she should be each year and to provide for repairs and for removal of wrecks at times when the boat is not in commission. The boat is well adapted for her work, but the work is very heavy and necessitates much renewal of various parts of machinery and outfit; besides, the boat is getting old and requires considerable repairs each year to keep her in effective working condition. To keep within the amount allotted it is necessary to lay the boat up for a part of the year when she might be usefully employed, and some parts of the river are not visited as often as they should be, and wrecks, of which there are many, which form dangerous obstructions, can not be removed as promptly as is desirable. I would earnestly recommend that the amount to be available each year should be increased to $50,000, or so much of that amount as might be necessary. With that amount the boat would be kept constantly in highly effective condition, could start out early enough each season to go over the entire river at least once, and most of the distance twice, and would make her service entirely satisfactory to the navigation interests, besides which wrecks could be removed promptly at times when the boat was not in commission or distant from the locality.

As stated in last report, the snag boat was ready to begin operations at the close of the fiscal year 1894, but that lack of funds had prevented her being sent out until after the funds for the new year became available. As a result, she was not able, on account of low water, to reach Pittsburg; in fact not getting nearer than 240 miles to that place. Considerable dissatisfaction has been felt and complaint made that the upper river does not receive its proportionate share of attention. But with the present limited amount of money available it is impossible, as a rule, to start the boat out in the spring in time to reach Pittsburg before she is stopped by low water. The only and effective remedy is the larger appropriation as just recommended.

The boat started upstream from Cincinnati July 2, 1894, running night and day, with the intention of reaching Pittsburg if possible. She stopped at Guyandotte Bar just long enough to remove a wrecked

coal barge and steamer which formed an almost prohibitory obstruction to navigation at that point.

Proceeding on her way she was stopped by low water at Syracuse, Ohio, about 240 miles below Pittsburg, July 6. She then began working her way downstream, but the river fell so much that on attempting to cross Guyandotte Bar, July 10, she grounded fast, and it was not until September 23 that she could get across. During this interval the crew were employed in removing large rocks and bowlders that obstructed seriously the channel from Proctorsville to Ironton, a distance of some 24 miles. Six wrecks, 362 snags, and 2,182 cubic yards of rock were removed. This work has been very beneficial and has long been needed. After getting off Guyandotte Bar, by the rise on September 23, the boat worked downstream to Louisville, but the river being too low to permit her passing below the falls, she started upstream and worked her way to Cincinnati. She started downstream again and worked down to Cairo, Ill., 967 miles below Pittsburg, reaching there December 3, being, however, delayed by low water from November 3 to 12 at Louisville, Ky. Leaving Cairo she worked upstream to the mouth of the Kentucky River, 541 miles below Pittsburg, which she reached December 19, and then went into winter quarters. From July 2 to December 19, inclusive, there were removed 1,163 snags, 47 wrecks, 2,182 cubic yards of rock and bowlders, and 2 leaning trees. The boat traveled a total distance of 1,869 miles.

To prepare for the coming season's work, the boat left her winter quarters April 4, 1895, and was brought to Cincinnati. The necessary annual repairs were completed June 19, 1895, and the boat placed in commission on the 20th. Between that date and the end of the fiscal year she removed 5 wrecks, 38 snags, and traveled a total additional distance of 146 miles. The farthest point upstream reached was Snag Creek, 432 miles below Pittsburg.

The boat could have been ready to begin the season's operations two months earlier had there been funds available for her work, and she could have commenced at the head of the river. As a result there is again a loss of two months' work, and on account of the low stage the upper part of the river is again denied any benefit from her work, probably for another whole season.

The work of the snag boat has been under the supervision of Capt. W. H. Christian.

OPERATIONS.

[Extract from the report of Capt. W. H. Christian.]

The snag boat *E. A. Woodruff* remained in winter quarters in the mouth of Kentucky River until February 27, 1894, when, pursuant to orders, she left Carrollton, Ky., landing at Cincinnati, Ohio, February 28, 1894, for the purpose of beginning the annual spring repairs to put the boat in condition for the coming season's work.

The repairs and betterments put on the boat consisted in removing the old and putting on a new roof; repairing the feed-water heaters of the large boilers; repairing the hydraulic, sheave, and tiller-rope parts of the steering apparatus; repairing the paddle wheels and wheelhouses; erecting a pair of new capstan engines and one new Providence steam capstan on the stern of the boat; erecting two new engines and fans in the compartments of the hull containing steam engines; erecting one new frame for the large wrecking hook, and making many minor repairs to the hull, upper works, snag and wrecking rigging, large boilers and furnace, steam pipes, and machinery generally.

The duty performed by the fans was specially valuable, as they cooled the compartments sufficiently to permit of continuous work therein when necessary.

The construction of the new wrecking hook frame, as compared with the old one, was greatly simplified and strengthened, for same weight, by using two I-beams

instead of a combination of riveted steel angle bars and plates, and the cost was reduced about 60 per cent.

The above-mentioned work was begun March 19 and finished May 24, 1894, when, on account of lack of funds, the crew was discharged until the beginning of the next fiscal year, July 1, when funds would be available for commissioning the boat for regular service.

After completing the repairs and providing for all the liabilities of the snag boat from the funds allotted for the fiscal year ending June 30, 1894, there remained a balance sufficient to employ part of the crew on the last three days of June to get everything in readiness for beginning regular work with the incoming fiscal year.

On July 2, 1894, the *Woodruff* left Cincinnati and steamed upstream, running day and night, until she reached Guyandotte Bar, 303 miles below Pittsburg, where she stopped to remove the wreck of a coal barge that had sunk directly in the channel, and the remains of the wreck of the steamer *J. C. Cressly*, which formed serious and almost impassable obstructions to navigation. After the removal of these wrecks, the snag boat proceeded upstream, running night and day, until Syracuse, Ohio, 239 miles below Pittsburg, was reached, July 6. After putting coal aboard and removing some troublesome snags in that vicinity the snag boat, due to the river being too low to proceed farther upstream, was headed downstream, and began the removal of obstructions from the river, some of which had been reported, but most of which were discovered by observations made from the snag boat. The snag boat continued work downstream to Gallipolis, 267 miles below Pittsburg, landing there on Saturday night, July 8, when, as usual, the boat was tied up and steam cooled down, to permit of cleaning boilers on Sunday morning, ready for regular work on Monday morning. Before tying the snag boat up, the officers of the Huntington and Gallipolis packet *Vesper* were consulted in reference to stage of water on Guyandotte Bar, and from their report—4 feet 4 inches—and the slow rate at which the river was falling, it was decided there would be sufficient water on the bar for the passage of the snag boat on Monday evening, and this would afford time and opportunity on Monday for the removal of the obstructions lying between Gallipolis and Guyandotte. But from some cause, supposably the raising of the dam at Davis Island some days previous, the fall of the river on Monday was unusual for that stage, so that when the snag boat reached the upper bar at Guyandotte she grounded, there being less than 3 feet of water there. The boat was sparred off the upper bar, but as the river continued to fall, there was still less water on the lower bar when the boat reached it, and the boat grounded harder than before. Upon examination, the channel below where the boat was aground was found covered with large, loose bowlders. It was then decided as better to allow the boat to remain where she was, on a sand and gravel bed, than to spar off and risk sticking on the rocks on a falling river, which would have resulted in perforating the bottom to a ruinous extent, and subsequent developments fully justified the course adopted. After sparring the snag boat straight with the current to prevent unequal scour under the boat, her crew was set to work on a barge that had previously been sent from Ironton, Ohio, to lighten the *Woodruff*, equipping it with capstan, derricks, tackle blocks, and tools taken from the snag boat. After which they were put to work removing the most dangerous of the many large rocks found in the channel between Guyandotte and Huntington. Later the work was extended above Guyandotte and below Huntington.

The snag boat remained fast on the bar from July 10 to September 23, 1894, and during that time as many of the crew as were retained were employed removing rocks and other obstructions from the river between Proctorville, Ohio, and Ironton, Ohio, covering a distance of about 24 miles, from which was taken 58,916 cubic feet of rock, 362 snags, and 6 wrecks. Many of the rocks removed had been, during every low-water stage, a serious menace to navigation, and in the past many petitions had been presented for their removal, but not for many years had the stage of water and other circumstances been so favorable for doing the work as were those of the summer of 1894.

September 23, at 1.30 p. m., a rise in the river floated the snag boat off Guyandotte Bar; she then proceeded to Huntington, W. Va., and tied up until the next (Monday) morning, when she steamed downstream, removing obstructions on the way, arriving at Cincinnati, Ohio, 466¼ miles below Pittsburg, September 27. She worked in the vicinity of Cincinnati until October 1, when she again started downstream, removing obstructions on the way until she reached Madison, Ind., 552¼ miles below Pittsburg, on October 4, where she stopped to remove the sunken hull of the steamer *City of Madison*. On October 10 the boat again started to work downstream, until she reached Louisville, Ky., 598¼ miles below Pittsburg, October 12. On arrival it was ascertained that the water in the Louisville and Portland Canal, and over the rocks at the foot of the canal, was too scant to permit the snag boat to pass. She was therefore, on October 13, started upstream and worked as far as Cincinnati, arriving October 26. Worked in the harbor and vicinity of Cincinnati until Novem-

ber 1, when she was again started downstream, reaching Louisville, Ky., November 3. The water still being too low to permit her to pass through the Louisville and Portland Canal or over the rocks at the foot, she was ordered to tie up there and await a rise.

At 6.45 a. m. November 12 the snag boat entered the Louisville and Portland Canal, passed through, and continued her regular work downstream until Tradewater Towhead, 862 miles below Pittsburg, was reached, November 23. Here she engaged in the removal of rocks, wrecks, and snags between the towhead and Kentucky shore, for the purpose of opening a new low-water channel for the passage of boats past what is commonly known as Caseyville Bar. On December 1 she left the chute at Tradewater towhead and worked downstream to Cairo, Ill., 967 miles below Pittsburg, arriving there December 5. After taking aboard stores the snag boat left Cairo December 5, and worked upstream to the mouth of the Kentucky River, 541 miles below Pittsburg, which was reached December 19, encountering no incidents worthy of note outside of usual routine work.

December 20 the crew commenced putting away rigging, tools, etc., and putting the snag boat in order for lying up over winter. This work was completed December 22, when all of the crew were paid off and sent home, except two watchmen and a cook, who remained with the captain to take care of the property.

Between July 2 and December 20, 1894, the *Woodruff* traveled 1,869 miles, removed 2,704 obstructions, exclusive of 28 small flatboat loads (4,171 cubic feet) of small stone, measured in bulk, but number not counted. Spent twelve and three-fourths hours dragging over locations of reported snags and old wrecks and breaking the crust of sand bars to assist scouring.

The *Woodruff* was in commission one hundred and seventy-seven days, and during that time was employed as follows:

	Days.
Running from Cincinnati to Syracuse	1½
Snagging, etc	33½
Wrecking, exclusively	12½
Boat aground, crew removing rock	73
Repairing	3
Sundays not worked	11
Sundays worked, sparring and repairing	4
National holidays not worked	2

Removed 1,163 snags, 47 wrecks, 59,259 cubic feet of rock, cut 2 leaning trees, and dragged 16 breaks and a great many landings, not counted, without finding anything.

Wrecks removed, classified, are as follows:

Steamboats	8
Steamboat bottoms	2
Coal boats, barges, and flats	32
Model barges	2
Ferryboat hull	1
Stone-boat hull	1
Pile-driver boat hull	1
Steamboats assisted	3

From the number of snags removed, the following, each weighing more than 50 tons, have been selected and their locations, distant from Pittsburg, given to show that large snags are not peculiar to any particular section of the river:

Location.	No.	Weight.	Below Pittsburg.
In front of—		*Tons.*	*Miles.*
Coal Grove Ferry Landing	1	118.000	330
Indian Creek	1	57.770	715
Foot of Three Mile Island	1	55.866	778
Pacific Point	1	95.566	833
Paducah, Ky	1	59.600	926
Paducah, Ky	1	88.210	928

The operations of the snag boat are reported by calendar years, as by this means each season's work is presented by itself. It is evidently necessary, however, in view of the limit to annual expenditures, to report the latter by fiscal years.

Itemized statement of expenses for operating snag boat on the Ohio River and removing snags, wrecks, and other obstructions in said river.

Month.	Pay of crew (labor).	Subsistence.	Fuel.	Miscellaneous supplies (hire).	Tools and implements.	General repairs and betterments.	Contingent expenses.	Total.
1894.								
July	$1,861.25	$622.63	$116.86	$149.88	$125.03	$200.88	$150.65	$3,227.18
August	1,492.67	488.54	.30	83.47	37.66	.....	96.48	2,199.12
September	1,602.56	599.94	99.10	89.96	15.39	28.38	142.99	2,578.34
October	2,003.92	292.15	265.88	40.48	28.10	84.62	.97	2,716.12
November	1,993.90	592.78	286.35	46.82	4.15	70.53	.60	2,995.13
December	1,550.59	160.33	335.70	13.31	.....	4.60	76.43	2,140.96
1895.								
January	406.40	21.50	.56	52.45	.....	.....	.....	480.91
February	416.50	24.82	.45	26.59	.....	.....	.....	468.36
March	400.00	28.76	.....	568.84	.....	.....	40.22	1,037.82
April	613.53	42.40	5.23	.....	.....	228.64	2.15	891.95
May	400.00	.....	.....	497.69	8.00	793.02	1.00	1,694.71
June	975.77	587.63	129.30	965.22	74.75	1,819.82	3.60	4,556.09
Total	13,717.09	3,461.48	1,239.73	2,534.73	288.08	3,230.49	515.09	24,986.69
'or removal of snags and wrecks at Phillissi Island, Line Island, and Raccoon Bar, Ohio River	20.50	.....	.....	1,128.82	.....	.....	41.65	1,190.97
ɔr operating snag ɔoat E. A. Woodruff.	13,696.59	3,461.48	1,239.73	1,405.91	288.08	3,230.49	473.44	23,795.72

C C 3.

ERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PENNSYLVANIA.

'he following is a statement of the amount and date of all allotments this work.

ıst 3, 1885	$5,865.00	October 7, 1890	$14,800.00
10, 1886	12,015.00	July 10, 1891	10,338.00
ary 28, 1887	6,700.00	July 21, 1892	11,831.48
1, 1887	12,355.00	June 27, 1893	1,300.00
ıary 25, 1888	3,500.00	July 22, 1893	12,253.82
1, 1888	18,015.00	July 18, 1894	12,459.02
ıt 20, 1889	12,073.00	May 25, 1895	450.00
4, 1890	2,000.00		
7, 1890	14,752.00	Total	150,707.32

the close of the last fiscal year the dam was up, having been June 15, 1894. The maneuvers during the year were as follows:

Dam lowered September 20, 1894.
Dam raised September 28, 1894.
Dam lowered December 2, 1894.
Dam raised May 2, 1895.

lam was thus raised and lowered twice and was up two hundred ır days. At the close of the year the dam was up.

ock has been in working order throughout the year. A device n attached to the gates to facilitate starting them from their hen closed, the severe strains having deformed them so that ration had become beyond the power of the engines. As these e old and the exposed parts quite badly decayed they require

It is proposed to embody in the new gates certain improve- hich experience shows to be desirable. The old wooden ring boat has been replaced by a larger one with new engines r power. It has proved very satisfactory. Spiral springs ı attached to the shafts of seven of the lock valves to prevent fts from being twisted when, in closing the valve, some

obstruction is met. The device accomplishes its purpose well, and will be placed on all of the maneuvering shafts as opportunity offers. The lock gate recesses are covered by wooden decking which decays rapidly. These should be replaced by iron work.

Twelve new wickets have been made for the navigable pass and four for the weirs, utilizing the irons of the old wickets in the new ones.

The guiding crib work above and below the lock, except 305 feet built in 1892, is becoming badly decayed and is much worn by action of ice at the upper end. Complete renewal will soon be necessary, as to repair the present structure would not be economical.

Considerable other work of minor nature has been done and all routine work attended to. For fuller detail, attention is invited to report of Mr. William Martin, assistant engineer, in immediate supervision of this work, an extract from which is appended.

Abstract of proposals for a steel maneuvering boat, received in response to advertisement dated December 7, 1894, and opened January 7, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Amount.
1	Thomas Carlin's Sons	$1,994.72
2	Edw. J. Howard	3,000.00
3	C. Jutte	4,250.00
4	James Rees & Sons	3,700.00
5	Riter & Conley*	1,988.00
6	M. A. Sweeney Co	3,490.00

* Recommended for acceptance.

Abstract of contracts.

Contractor.	Work of improvement.	Date of contract.	To expire.
Riter & Conley	Maneuvering boat	Jan. 18, 1895	Mar. 15, 1895.*

* Extended to April 1, 1895.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. William Martin.]

A hand railing at the top of the railroad embankment extending from the railway station to the lock-keeper's house has been built. The object of this is to keep the public from trespassing on the embankment, which prevents a sod being cultivated. The railing is composed of oak posts firmly planted in the ground with horizontal holes in the top, through which a wrought-iron pipe is passed which forms a guard.

The difficulty heretofore experienced by the lock-valve shafts becoming twisted has been overcome by the application of spring attachments. The device is a spiral spring 1½ inches diameter, and is so arranged that when any stoppage gets into a valve and prevents its closing, the action of the spring prevents the power of the hydraulic jack twisting the valve shaft. These springs have only been attached to the upper gate recess valves, seven in number. The others will be applied as soon as a favorable opportunity offers.

The roofs of the shops, both on the island and lock side of the river, and the dam-tender's house on the island have received a coat of iron-ore paint.

The sewer built to carry the drainage from the lock-keeper's house, and which connects with the upper pool at the upper gate recess, has been choked for several years; several attempts have been made to remove the stoppage. I have succeeded during the year in clearing it out and giving the water a clear passage through it.

On the 5th of September the river receded to a stage of 0.70 feet by the lower gauge of the lock. This is the lowest recorded stage of water we have any record of, and from verbal reports it is the lowest known previous stage.

On the 19th of September unprecedented rains fell at the headwaters of the Allegheny River, which brought a very sudden rise in the Ohio River. As frequently

happens, our telephone connecting with the Pittsburg Telephone Exchange is so charged with induction as to render the instrument worthless. No reports of the amount of rainfall or rise in the rivers at headwaters could be received at the dam until 10 o'clock in the morning of the 20th. Weir No. 3 and the bear trap had already been lowered early in the morning, but without any effect in lowering the pool. An attempt was made to lower the pass by the usual method when the pool was 12.80 feet (12.15 feet being normal), but were unable to accomplish anything, the draft of water over the dam being so great the maneuvering boat could not be handled. Three steamboats were called into service, and the navigable pass was put down and open to navigation at 4.45 p. m.

Two barges of coal belonging to the McKinley Coal Company, of Pittsburg, Pa., were sunk on the 21st of September by the steamer *J. A. Blackmore*, at the head of the river lock wall. They were removed by the U. S dredge *Oswego*, after a formal abandonment by the owners.

By authority of your letter dated October 3, 1894, a long-distance telephone was placed in this office. A long-distance telephone has a metallic circuit and is free from the inductive influence of the electric-light wires, which was the prime cause of our difficulty with the ground-circuit instrument on the morning of September 20, when, by failure of the telephone, reports of the flood at that date could not be received.

The tracks for running the lock gate engines to the rear, being built of timber, became badly decayed. They were built on an incline to raise the engine 5 feet above the lock walls. The lower track became dangerous for further use, and was torn down and rebuilt on the level of the coping.

The lock gate recesses are covered by wooden decking, which decays rapidly. Two decks have already been put on and again require renewing. It would be economical to replace the wooden decks by iron.

Twelve new wickets for the navigable pass and four for the weirs were built. The rons of old wickets were used for the new ones.

The old wooden maneuvering boat was replaced by a steel one 16 feet wide, 53 feet 6 inches long, and 3 feet deep, built by Messrs. Riter & Conley of Pittsburg, Pa. new hoisting engine was purchased from Thomas Carlin's Sons of Allegheny, Pa., r use in the equipment of the boat. All the machinery of the old boat except the gine and capstan were fitted to the new boat.

The lock gates are now in their tenth year of service, and, being built of timber, exposed parts are very much decayed. The gates have at various times under- e extensive repairs, the principal cause of which has been the lateral sliding action he gate on its wheels. This action produces such a severe strain on the lower cture of the gate that the wheels are continually working off their axles. The e necessary to draw the wheels off must be very great when the fact is known they are put on with a key and the end of the shaft riveted over the hub of the el. The dropping of a wheel is a very frequent occurence and there is no way to it without making a change in the design of the wheel and axle. The lower ture of the gate has sustained such severe strains that the labor of starting it opening taxes the power of the engine and chain beyond their maximum. To ome the inertia of the gate when starting I have arranged a lever on each fulcrumed to the upper top rail of the gate with the short end of the lever ig against the river wall. The long end of the lever is attached to the gate which acts on the lever first and then on the tug link to which the chain is ed, thus adding the power of the lever as an aid in starting the gate.

guiding cribs both above and below the lock are a timber framework filled tone. The cribs as originally built are of the following dimensions: The crib is 710 feet long by 15 feet wide, and the lower one 250 feet long by 15 feet id 17 feet high. In the year 1892 an extension was made to the lower crib t long by 12 feet wide and 11.50 feet high. This latter crib is in good condi- n the former the timber is very much decayed. The upper end of the upper worn away by the ice about 29 feet. These original cribs are not worth ing to repair, as the timber is so much decayed that nothing short of a com- newal would justify any expenditure of money.

ock river dam has been in good repair throughout the year with the excep- few loose planks, which were more securely spiked.

ea in front of the lock-keeper's house has been filled up with material from the Pittsburg, Fort Wayne and Chicago Railway. Grass seed has n to form a sod. When the earth filling has thoroughly settled, walks will rom the house to the front walk.

close of the last fiscal year the dam was up, having been raised June 15, s maneuvers during the year were as follows:

am lowered September 20, 1894.
m raised September 28, 1894.
m lowered December 2, 1894.
m raised May 2, 1895.

Duration in days of the various stages of water in the Ohio River at the Davis Island Dam for nine years ending December 31, 1894.

Month.	1886.			1887.			1888.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	0	31	28	0	31	17	1	30	19
February	0	28	21	0	28	28	0	29	28
March	0	31	17	0	31	18	0	31	29
April	0	30	21	0	30	13	0	30	25
May	0	31	11	0	31	16	0	31	13
June	2	28	5	3	27	7	1	29	2
July	7	24	0	21	10	0	3	28	8
August	7	24	3	27	4	0	13	18	6
September	19	11	0	30	0	0	1	29	6
October	26	5	0	30	1	0	1	30	23
November	12	18	16	19	11	0	0	30	25
December	0	31	22	2	29	0	0	31	18
Year	73	292	144	132	233	99	20	346	201

Month.	1889.			1890.			1891.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	0	31	30	0	31	31	0	31	31
February	0	28	13	0	28	28	0	28	28
March	0	31	29	0	31	31	0	31	31
April	0	30	25	0	30	26	0	30	26
May	0	31	21	0	31	31	1	30	0
June	0	30	30	0	30	31	0	30	21
July	0	31	13	14	17	1	0	31	13
August	5	26	2	13	18	9	0	31	12
September	18	12	0	0	30	21	9	21	4
October	6	25	8	0	31	31	20	11	0
November	0	30	30	0	30	29	9	21	7
December	0	31	31	0	31	17	0	31	29
Year	29	336	227	27	338	286	39	326	202

Month.	1892.			1893.			1894.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	0	31	22	0	31	6	0	31	31
February	0	29	27	0	28	28	0	28	28
March	0	31	29	0	31	31	0	31	31
April	0	30	30	0	30	30	0	30	30
May	0	31	29	0	31	31	0	31	30
June	0	30	22	1	29	8	0	30	12
July	0	31	5	10	21	0	27	3	0
August	14	17	0	29	2	0	31	0	0
September	21	9	0	25	5	0	12	18	7
October	31	0	0	15	16	2	24	7	0
November	1	29	2	2	28	4	0	30	2
December	0	31	12	0	31	31	0	31	17
Year	67	299	178	82	283	166	94	270	178

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1895.

Month.	Operating expenses.				Maintenance and repairs.					
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Labor.	Material.	Plant.		Total.	Aggregate.
							Purchase and repair.	Hire.		
1894.										
July	$775.00	$60.26	$62.26	$897.52	.....	$50.78	$14.60	.....	$65.47	$962.99
August	538.00	59.95	329.54	927.49	$24.75	38.60	14.70	.....	78.05	1,005.54
September	709.00	52.03	232.27	993.30	23.56	352.65	.....	.....	376.21	1,369.51
October	530.00	68.19	52.74	650.93	.....	.....	.....	.....	.....	650.93
November	726.67	126.27	51.07	904.01	.....	.....	.....	.....	.....	904.01
December	510.00	105.22	20.47	635.69	.....	48.31	50.63	.....	98.94	734.63
1895.										
January	700.00	34.50	1.66	736.16	.....	157.74	7.53	.....	165.27	901.43
February	500.00	29.17	1.57	530.74	.....	7.40	948.00	.....	955.40	1,486.14
March	691.67	39.15	51.29	782.11	.....	.....	1,988.00	.....	1,988.00	2,770.11
April	506.00	.....	65.47	571.47	15.20	.....	54.49	.....	69.69	641.16
May	740.86	.....	83.15	824.01	.....	.....	.....	.....	.....	824.01
June	539.00	7.50	147.32	693.82	.....	110.26	.....	.....	110.26	804.08
Total	7,466.20	582.24	1,098.81	9,147.25	63.51	765.74	3,078.04	.....	3,907.29	13,054.54

Commercial report for calendar year ending December 31, 1894.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.		Through pass.		Through lock.		Through pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	63	2,241	276	18,675	66	3,161	269	29,517	53,594
Towboats	198	.....	1,056	.....	148	.....	1,124	.....	.....
Model barges	6	.....	37	.....	.....	.....	60	42,123	42,123
Coal boats	154	.....	344	.....	.....	.....	1,225	1,109,512	1,109,512
Barges	577	.....	2,502	9,224	54	12,905	2,971	1,554,117	1,576,246
Flats	301	3,895	961	11,679	177	16,469	1,243	181,450	213,493
Rafts	.....	.....	1	500	5	1,437	38	148,698	150,635
Miscellaneous	35	.....	84	200	56	.....	89	.....	200
Total	1,334	6,136	5,261	40,278	506	33,972	7,019	3,065,417	3,145,803

C C 4.

MOVABLE DAM IN OHIO RIVER BELOW MOUTH OF BEAVER RIVER, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this work:

eptember 19, 1890	$250,000
uly 13, 1892	[1] 100,000
ugust 17, 1894	75,000
[arch 2, 1895	150,000
Total	575,000

This dam, which is located 30 miles below Pittsburg, Pa., will be the xth in the series of movable dams for improving the Ohio River by ack-water navigation. Davis Island Dam, located 4½ miles below ittsburg, and which has been in successful operation since October, 85, is the first of the series.

[1] The bill provides that so much of this money as may be necessary may be used making survey for location of Dam No. 2 and acquiring title to the land. The vey has been made.

Active work of construction was resumed July 20, 1894. Masonry work was continued until December 11, and work of excavating the lock chamber until January 5, 1895, when all operations were suspended for the season.

The following is a summary of the work accomplished:

	Cubic yards.
Excavation made, earth	11,892.9
Excavation made, rock	1,279
Concrete laid	2,177.1
Ashlar masonry laid	968.35
Rubble masonry laid	299.8
Brick masonry laid	407.4
Coping laid	663.6

The excavation of this work completed about 80 per cent of all work to be done on the lock, exclusive of operating machinery and power house. The latter was partly built in 1892–93, and drawings of the former are made.

The cofferdam built in the fall of 1892 had become more or less deteriorated. The rapid rise of January 7 last brought such a pressure on it before it could be filled that it gave way and 330 feet were destroyed. The loss was of but little importance, as by building two short spurs to connect the portions remaining on each side of the break with the completed river wall all work yet to be done was inclosed, and the extra expense was small. This work was done in May, 1895, and during June all preparations were made for an active prosecution of the work.

This work has been under the immediate supervision of Mr. William Martin, assistant engineer.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. William Martin.]

Active operations were begun on the 20th of July, 1894, getting the temporary plant in readiness for the ensuing year's work. The project for the year included the continued construction of the land-wall masonry and the drift chute; the construction of the flushing conduits and laying of the coping of both land and river walls of the lock.

On July 31, 1894, we had employed 45 men; this force was gradually increased until September 1, 1894, when we had 150 men, the greatest number employed at any one time during the season.

Stone had been ordered and was being received, both cut stone and rough stone for specials, so that at this time no delay was being experienced in the masonry construction. Stonecutters were engaged and masons put to work continuing the construction of the land-wall masonry early in the season. A force of men was also put to work on the flushing conduits later in the season; about the month of October active work was begun on the extension of the drift chute. At this time, also, the laying of the coping of the land wall was commenced; the river-wall coping was not begun until November, and both walls having been covered as far as completed, work upon the coping was suspended early in December. During the latter portion of the season delay was encountered in the delivery of the large coping stone in consequence of the contractor's inability to furnish it from his own quarry. This stone was subsequently received from the Massillon and Freeport quarries of Ohio. This work is now all complete as far as the present project will permit.

The season was a favorable one for work, and the river was never high enough to interfere with the work, except September 20, when the cofferdam inclosure was flooded for a period of four days. On January 7, 1895, while work in the excavation of the lock chamber was going on, we were suddenly overtaken by a flood. The river was rising at the rate of 2¼ feet per hour; the flood gates had been opened to fill the cofferdam inclosure, but before this had any effect 330 feet of the lower end of the outer wall gave way. Every effort was being made to get the traveling crane to a place of safety, but without avail, for it had to be abandoned when the cofferdam broke. The crane was left on its track in the lock, and when the ice breaking of the upper rivers occurred the lock chamber became gorged with ice, overturning the traveling crane.

About June 1, 1895, the cofferdam was repaired by building spurs to the river wall from that portion of the cofferdam remaining, and the inclosure was pumped out. The traveling crane was found to have sustained very little damage as a result of passing through the floods.

The following is a summary of work done and material received during the year in permanent structures:

River wall of lock:		
446.7 cubic yards coping, at $20.02 per cubic yard		$8,945.64
42.68 cubic yards ashlar pierheads, at $18.05 per cubic yard		770.66
9.10 cubic yards rubble backing, at $6.28 per cubic yard		57.20
Cost of material	$3,242.03	
Cost of labor	6,531.47	
Total cost		9,773.50
Land wall of lock:		
925.67 cubic yards ashlar masonry, at $9.99 per cubic yard		9,247.41
106.90 cubic yards rubble masonry, at $5.58 per cubic yard		597.17
216.90 cubic yards coping masonry, at $19 per cubic yard		4,123.19
1,146 cubic yards concrete masonry, at $3.16 per cubic yard		3,623.19
113 cubic yards excavation, at 40 cents per cubic yard		45.20
Cost of material	$11,507.92	
Cost of labor	6,128.24	
Total cost		17,636.16
pper gate recess:		
20 cubic yards rubble masonry, at $5.86 per cubic yard		117.37
Cost of material	$71.47	
Cost of labor	45.90	
Total cost		117.37
wer gate recess:		
163.8 cubic yards rubble masonry, at $5.99 per cubic yard		983.18
Cost of material	$579.18	
Cost of labor	404.00	
Total cost		983.18
er flushing conduit:		
10.70 cubic yards brick masonry, at $10.84 per cubic yard		1,201.14
68.20 cubic yards rock excavation, at $1.159 per cubic yard		658.76
,571 cubic yards earth excavation, at 39.6 cents per cubic yard		623.41
21.20 cubic yards concrete, at $3.29 per cubic yard		729.26
ost of material	$909.78	
ost of labor	2,302.79	
Total cost		3,212.57
flushing conduit:		
).3 cubic yards brick masonry, at $8.27 per cubic yard		1,153.58
).8 cubic yards rock excavation, at $1.13 per cubic yard		807.48
cubic yards earth excavation, at 38.6 cents per cubic yard		313.04
.9 cubic yards concrete masonry, at $3.03 per cubic yard		983.90
t of material	$1,176.51	
t of labor	2,081.49	
otal cost		3,258.00
ute:		
4 cubic yards brick masonry, at $7.98 per cubic yard		1,257.20
ubic yards concrete masonry, at $2.69 per cubic yard		1,306.31
cubic yards excavating and shoring, at 65.8 cents per cubic yard		1,096.41
of material	$1,565.79	
of labor	2,094.13	
al cost		3,659.92

Excavation of lock chamber:
7,732.9 cubic yards, at 39.76 cents per cubic yard..... $3,075.01

Material received:

Natural cement	barrels	4,300	
Sand (X)	bushels	154.86	
Ashlar	yards	1,185.5	
Portland cement	barrels	30	
Red brick		172,000	
Specials	yards	851.7	
Large rubble	do	38.79	

River wall.—With the exception of the pierheads at the upper and lower ends and gap at the center, the ashlar of the river wall had been already completed. During the year the pierheads have been built, consisting of ashlar masonry with face battered and rounded ends backed with rubble; also the coping extending from both the upper and lower ends to the gap, so that now the masonry of the river wall is complete, only the gap, comprising 700 yards of ashlar masonry and 168 yards of coping, remaining to be done. All the coping on the river wall was laid with the traveling crane.

There is a noticeable increase in the cost of coping in the river wall over that of the land wall; this is mainly due to the machinery well, which does not exist in the land wall.

Land wall.—Except the gap at the center, and the omission of a few yards of masonry at the upper and lower ends of the wall, for the anchorage of machinery, the land-wall masonry is complete. To finish the wall will require about 635 yards more of ashlar and concrete and 100 yards more of coping. The wall consists of a stone face with an average or mean width of 3.7 feet, the balance being constructed of concrete. At the base the wall is 8 feet wide, and continues thus for 6 feet, after which it tapers to five feet at the top, under the coping. Until set the concrete was held in place by shoring.

The traveling derrick was used in delivering the stone where needed, stationary derricks being used for setting the stone.

To complete the land-wall foundation it will require the excavation of 142 yards of earth and putting in of 127 yards of concrete foundation.

Gate recesses.—The upper gate recess remains substantially as it was last year, the small quantity of rubble masonry reported being only added in making the connection with the land wall.

The masonry of the lower gate recess has during the year been advanced to the same point as the upper recess, and now only a small portion on each of the parapets supporting the recess decking, amounting to about 125 yards of masonry, remains to be completed.

These gate recesses are built of large rubblestone, jointed and bedded and having a rock face. Mortar used was made of natural cement and sand, mixed in the proportion of one part cement to two of sand.

Flushing conduits.—By the omission of the lock-filling and discharge valves in the gate recesses, as at Davis Island, it was necessary to construct flushing conduits to clear the recesses of deposit and other débris. At the upper gate the conduit is built from the rear of the recess, and enters the lock through the land wall at a point 100 feet below the lock gate; at the lower gate the conduit begins at a similar point in the recess and discharges into the lower pool 100 feet below the gate. The conduits are 8 feet wide, with walls 4 feet 3 inches high, and covered by a brick arch with a rise of 1 foot to 6 inches; each has a sectional area of 42.23 square feet, and with a full head of 7 feet (that is, with a full pool below) and discharge valve open, has a velocity of discharge of 17.3 feet per second in the conduit, creating in the recess a scouring velocity of about 2.5 feet per second.

The conduits have a concrete foundation, with 4½-inch brick pavement, 9-inch brick walls backed up with concrete, and covered with a brick arch of four rings, having concrete spandrel backing. They are each 151 feet long; the upper conduit has been completed, while there are still 32 feet of the lower one unfinished. In making the excavations for these conduits considerable rock was encountered, principally at the end next the bank; also in the lower conduit great depth of excavation had to be made, due to its proximity to the bank, together with consequent increased shoring necessary; all these tended to augment their cost. The excavated material was disposed of with one handling, and that principally with a derrick.

Drift chute.—The lock gate proposed to be used being of the rolling type, the same as used at Davis Island Dam, it was necessary to provide a drift chute to carry off the quantities of floating débris which collected in the gate recesses. As a means to relieve the recesses of this material, this conduit was built. It leads from the upper recess, beneath the power house, to the rear end of the lower recess, where it is joined by an outlet, emptying into it from the latter, and runs thence on a curve to an outlet through the guiding crib into the lower pool. It is 6 feet wide, having

a 4½-inch brick pavement over a foundation of 8 inches of concrete, with 9-inch brick walls 3 feet high, backed up with concrete, and covered with a three-ring brick arch of 3 feet radius. It is designed for the disposal of all floating débris getting into the recess, which is thus carried both from the upper recess and the lock inclosure through the conduit into the pool below.

The reference of the pavement at the upper recess is 2 feet below the pool level, having a fall of 1 foot in 300, creating a velocity of about 7.2 feet per second in the chute. This conduit, passing under the power house, also serves the additional purpose of carrying away any of its waste accumulations. The portion above the power house has now been completed, about 40 linear feet having been constructed to connect with the upper recess; below the power house it had been completed to within a few feet of the upper side of the lower recess. During the year work was continued from this point around the rear of the lower recess, connection being made with the outlet therefrom, and then extended to within 62 feet of the outlet in the lower guiding crib. Thus there remains only 62 linear feet to complete this work.

Excavation of lock chamber.—The excavation of the lock chamber was carried on almost continuously from October, 1894, to January, 1895, beginning at the upper end and working toward the lower end. It is now about half finished, the lower half still remaining to be done. The material was lifted by the traveling crane from the chamber and conveyed to various points in the land-wall inclosure. As the work of excavating next the river wall receded from the upper end of the chamber, the traveling crane tracks were torn up.

During the year a small quantity of sand was purchased, but the greater portion used has been taken from excavations of the lock chamber and foundations; it is of an excellent variety, coarse, sharp, silicious, and gritty.

Plant.—The plant has not suffered any marked injury during the winter season, and was in a comparatively good condition when operations were begun. At the suspension of the previous season's work, everything possible had been done to protect and preserve such portions of the plant as could not readily be removed to a place of safety, so that in beginning operations it was only necessary to put them in position for the season's work. The pumps were set up and started pumping out the cofferdam. The stone incline, which had been taken down, was rebuilt. The concrete mixer was given an overhauling and cleaning. The traveling crane tracks were cleared of the large stones which had been placed there to anchor them when under water. The iron derricks and hoisting engines, which had been taken down previous season, were set up at the various points over the work where needed. In the arrangement of the plant it has been the endeavor, so far as possible, to conform to conditions of economy.

Office work.—The office force has been, for the most part, continuously and regularly engaged upon the various duties pertaining to the office. All drawings of masonry and special stones and such other drawings as were required were made and supplied whenever needed. Drawings for various projects of work to be done have been made from time to time and submitted for approval. The time has been kept and divided that with very little additional labor in dividing and apportioning it the cost of the various operations, both temporary and permanent, can be easily ascertained. This affords a very ready source of information for deducing the unit cost of any work done during the season.

Tests of cement were regularly and faithfully made of every shipment received. The tests have been carefully tabulated in a book of record kept for that purpose.

Money statement.

1894, balance unexpended		$79,144.44
Amount appropriated by act of August 17, 1894		75,000.00
Amount appropriated by sundry civil act approved March 2, 1895		150,000.00
		304,144.44
1895, amount expended during fiscal year		75,201.37
1895, balance unexpended		228,943.07
1895, outstanding liabilities	$6,849.38	
1895, amount covered by uncompleted contracts	17,428.59	
		24,277.97
1895, balance available		204,665.10
Amount (estimated) required for completion of existing project		325,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		100,000.00

Appropriated in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Commerce passing the site of Movable Dam No. 6, Ohio River, in 1894.

Vessels.	Ascending.		Descending.	
	Number.	Freight.	Number.	Freight.
		Tons.		*Tons.*
Packets	325	35,000	314	33,800
Towboats	883	.....	871	.....
Model barges	43	.....	60	57,000
Coal boats	498	.....	1,225	1,117,200
Barges	3,079	.....	3,025	1,609,300
Flats	1,262	.....	1,220	185,440
Rafts	.....	.....	22	66,000
Total	6,090	35,000	6,737	3,068,740

List of articles received and shipped at wharf boat at Rochester, Pa. (the only one between the site of Lock No. 6, Ohio River, and Pittsburg), during the year 1894.

Months.	Iron and steel.	Glass-ware.	Tumblers and bottles.	Lumber.	Miscellaneous.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	50	25	70	.....	32	177
February	45	20	51	.....	27	143
March	48	22	56	150	31	307
April	25	24	62	200	28	339
May	24	26	76	250	33	409
June	20	21	38	200	.....	279
July (river very low)	.....	.....	.....	.....	20	20
August (navigation suspended)	.....	.....	.....	.....	.....	.....
September (river very low)	.....	.....	.....	.....	25	25
October (navigation suspended)	.....	.....	.....	.....	.....	.....
November	50	20	64	200	30	364
December	120	25	65	.....	35	245
Total	382	183	482	1,000	261	2,308

During the months of navigation the passenger business amounted to $650 per month from Rochester, Pa., to points below; the number of passengers carried could not be obtained.

At Rochester there is the largest tumbler works in the world; near by are numerous glass and bottle factories and iron and nail mills, all of which avail themselves of the river for transportation when the stage of water permits.

C C 5.

ICE HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for the work:

March 3, 1879	$30,000	August 5, 1886	$37,500
June 14, 1880	50,000	August 11, 1888	60,000
March 3, 1881	30,000	September 19, 1890	30,000
August 2, 1882	40,000		
July 5, 1884	50,000	Total	327,500

The ice harbor is the lower pool of the Muskingum River, which has been created by the slack-water dam at Marietta, and the object of the work under consideration is to build a pass way through this dam of such size as will permit Ohio River packets and coal fleets to take

refuge from ice in this pool. The passway in question consists of a large lock, which, owing to the local conditions controlling the only available site, was built with independent axes of entrance and exit, the angle between these axes being 11° 15′. This construction involved the necessity of widening the lock chamber at both ends so as to permit boats to change direction while in the lock. The plan of the lock chamber is therefore somewhat like an hourglass, the lock being narrowest in the middle. The maximum rectangle which can be passed through the lock has a length of 365 feet and a width of 56 feet. The work has been in progress since 1880, but has been kept back by inadequate appropriations and the occasional absence of any appropriation. The lock is now nearly finished and is in use, but requires some additional work in providing machinery for operating the gates and finishing a small amount of masonry. Middle gates should be provided for more rapid operating in passing the boats that use the lock most. A lock-keeper's dwelling should be built, and the grounds about the lock, which belong to the city of Marietta and have been used by the United States for a number of years without cost, should be placed in presentable order, all of which will cost about $10,000.

The river and harbor act of August 17, 1894, provided for the work outlined, diverting for this purpose so much of the funds remaining to the credit of the "Taylorsville Lock appropriation" (improving Muskingum River, Ohio) as may be necessary. This work will be done during the ensuing season.

The same act provided for the necessary alterations in the Baltimore and Ohio Southwestern Railway Bridge so that the lock shall be accessible to Ohio River commerce. This involves the substitution of a drawn in place of the fixed span which now obstructs the entrance. The part of the work devolved upon the United States by the act includes everything except the superstructure. Payment is to be made from funds available for the care and maintenance of public works.

The report of work so far done under these provisions is given in the report on operating and care of locks and dams on Muskingum River,

commercial statistics are attached to the report for operating and of locks and dams on the Muskingum River.

This work has been under the immediate supervision of Mr. Edmund Moeser, assistant engineer.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

Lock through Dam No. 1, Muskingum River, though incomplete, has been successfully operated during the year.

There were no expenditures for construction under the appropriation of September 19, this appropriation being practically exhausted.

Under the river and harbor act of August 17, 1894, providing for the completion of the preparations for completing the work as projected were made.

Money statement.

1894, balance unexpended	$30.68
1895, amount expended during fiscal year	4.86
1895, balance unexpended	25.82

C C 6.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for this work:

Act of August 11, 1888 ..... $102,000

The lock at Taylorsville is now practically completed with the exception of machinery for operating the gates, but this lock can not be made available until a draw is placed in the county bridge just below it.

The river and harbor act of August 17, 1894, provided, however, for making the necessary changes in this bridge, under the terms of which the United States is to do all the work necessary except that relating to the superstructure. Payment is to be made from the funds provided for the care and maintenance of public works. The report of work so far done under these provisions is given in the report on operating and care of locks and dams on the Muskingum River.

The act of August 17 also provided for a survey of the Muskingum River from Zanesville to Dresden. The survey has been made and report on the results, with estimates of the cost of extending slack-water navigation to Dresden, submitted under date of February 27, 1895.

With regard to the reconstruction of the lock at Zanesville, in the Annual Report of the Chief of Engineers for 1889 it was recommended that the alterations of the Zanesville locks be indefinitely postponed. Congress has apparently acquiesced in this recommendation, as the last river and harbor act requires the funds available for this work to be used for the survey mentioned above, for completion of the ice harbor at the mouth of the river, and for completion of the Taylorsville Lock, thus diverting the funds that would otherwise be available for their reconstruction to other uses. The existing locks can be kept in operation for some time yet without costly repairs.

This work has been under the immediate supervision of Mr. Edmund Moeser, assistant engineer.

Commercial statistics are attached to the report for operating and care of locks and dams on Muskingum River.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

The only work carried on under this appropriation has been that of making a survey from Zanesville to Dresden, Ohio, in compliance with provision in the river and harbor act of August 17, 1894.

A detailed survey was made of the stretch of river between Zanesville and Dresden, 15.34 miles in length; the work was platted and maps with estimates of cost of obtaining a navigable depth to Dresden were submitted February 26, 1895.

The cost of the survey was $1,227.08.

It was thought unadvisable to complete the work yet to be done on new lock at Taylorsville until a draw is placed in the county bridge just below it; the matter of reconstructing this bridge being now settled, it is hoped that the work yet to be done on lock to make it available for navigation will be completed during the present working season.

Money statement.

July 1, 1894, balance unexpended	$13,754.57
June 30, 1895, amount expended during fiscal year	1,290.93
July 1, 1895, balance unexpended	12,533.64
July 1, 1895, outstanding liabilities	8.40
July 1, 1895, balance available	12,525.24

C C 7.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations and allotments for this work:

August 5, 1886 (appropriated)	$20,000.00	November 24, 1891 (allotted)	$1,200.00
July 21, 1887 (allotted)	190,000.00	December 9, 1891 (allotted)	1,200.00
August 13, 1888 (allotted)	177,623.00	January 5, 1892 (allotted)	12,241.54
July 1, 1889 (allotted)	232,080.00	August 3, 1892 (allotted)	42,919.47
July 19, 1890 (allotted)	195,665.00	July 22, 1893 (allotted)	52,745.36
May 28, 1891 (allotted)	20,000.00	July 25, 1894 (allotted)	47,157.66
July 8, 1891 (allotted)	155,200.00	Total	1,188,012.03
November 9, 1891 (allotted)	39,980.00		

Special work authorized by act of Congress.

March 21, 1895 (allotted), protection wall at Zanesville	$1,651.00
June 17, 1895 (allotted), pier of railroad bridge at Marietta	10,449.60
June 17, 1895 (allotted), pier of county bridge at Taylorsville	5,834.20
Total	17,934.80

As originally improved by the State of Ohio, 11 dams and 12 locks ere built on the Muskingum River, furnishing continuous navigation r 91 miles from the Ohio River at Marietta to Dresden, where a conection was made with the Ohio Canal near its middle point, this canal tending from the Ohio River at Portsmouth to Lake Erie at Clevend. The work cost the State of Ohio about $1,500,000. The lock and m above Zanesville is now in a state of ruin, but the 75 miles of slack ter between the Ohio River and Zanesville have always been mainned. On this piece of river there are 10 dams, 11 locks, and 5 lateral als, with a total length of 3⅔ miles.

The locks and dams were about worn out when they passed into the ds of the United States in April, 1887, and a general reconstruction unavoidable, the greater part of which has been completed. Good igable depth was maintained throughout the year, notwithstanding extreme drought of the summer of 1894. There was no interruption avigation by failure of any of the structures. It was, however, rely suspended by ice during a period of sixty-four days. The ficial effects of the dikes built last year to prevent further erosion e banks at Dams Nos. 2, 4, 5, 6, 7, and 8 have continued and no er trouble is anticipated at these dams. All the repairs contemd for the year were nearly completed and incidental repairs made uired.

main items of work were as follows:

Lock and Dam No. 1.—Closing a large leak under foundations of

Lock and Dam No. 2.—Replacing coping of lock walls and repointamber faces.

Lock and Dam No. 3.—Replacing sheeting on 32 linear feet of filling several empty cribs, and placing backing behind the dam.

Lock and Dam No. 4.—Rebuilding 40 feet of guiding crib and to canal bank 200 feet above head of lock.

Lock and Dam No. 5.—Rebuilding 60 feet of guiding crib and extenpairs to lock-keeper's dwelling.

Lock and Dam No. 6.—Rebuilding 234 feet of the dam.

At Lock and Dam No. 7.—Repairing dam and outlet of turbine culvert.

At Lock and Dam No. 8.—Repairing dam and completing spur dike.

At Lock and Dam No. 9.—Repairing dam for about 130 feet of its length.

At Lock and Dam No. 10.—Repairing lock, gates, and dam.

From time to time it will be necessary in the near future to repair or replace certain portions of the old work, especially dams, as they become dangerous.

The U. S. dredge *Malta* and steamer *Vega* rendered good service throughout the year.

Under the provisions of the last river and harbor act the expense to be borne by the United States in making such alterations as were needed in the county bridge below the new lock at Taylorsville, and in the Baltimore and Ohio Southwestern Railroad Bridge below the lock at Marietta, so as to permit the operation of the first lock and to render the second accessible to Ohio River commerce, is to be met from funds available for the care and maintenance of public work. By the terms of the act the United States is to perform all the work necessary, except so far as the superstructure is concerned. This practically involves in each case the construction by the United States of a pivot pier, with the necessary guiding and protecting crib or pile work extending above and below the pier. Under project dated May 4, 1895, approved June 17, 1895, much of the necessary material has been purchased and active work of construction will soon begin.

The sundry civil act of March 2, 1895, also provided for the reconstruction of a protection wall on the right bank of the Muskingum River near the Main Street Bridge at Zanesville, Ohio, payment to be made from funds available for the care and maintenance of public work. Under project dated March 16, approved March 21, 1895, the work was commenced April 20 and completed in June.

This work has been under the immediate supervision of Mr. Edmund Moeser, assistant engineer.

It having been decided by the Secretary of War, upon the recommendation of the Chief of Engineers, that no funds could be supplied from the indefinite appropriation for operating and care of canals and other works of navigation for any work whatever except for actual cost of operating and care, there are no funds available for any betterment of the works or for needful additions. There are lock-keepers' dwellings at five of the locks, but none at the other five. Certain improvements, such as additional guide cribs at entrance of locks, would be of material benefit to navigation. In order to provide for such work I would earnestly recommend that the amounts received by the Government for rental of lands and water power along the river, which is now turned into the Treasury by the officer in charge of the work, should be deposited to that officer's credit and be made available for such work of improvement on the river. The amount collected each year is not large. This year it was $3,310.43.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

With the exception of some extraordinary repairs rendered necessary by accident, and minor incidental repairs, needful in maintaining the locks, dams, and canals in an efficient condition, all work done was in accordance with approved project of repairs for the year.

The canals and locks were kept in good working order, and there was no interference with navigation except when the river was closed by ice.

The season of 1894 was one of extreme drought of unprecedented duration, but owing to the generally good condition of the dams, very little effort was necessary to maintain the pools at their normal levels.

During the past winter there was an entire suspension of navigation by ice for a period of sixty-four days.

No floods of sufficient height to submerge the locks occurred.

The beneficial effect of the dikes constructed at Dams Nos. 2, 4, 5, 6, 7, and 8 is very marked. No further washing and considerable filling has taken place at all of the dikes, since their construction.

The following is a detailed statement of work done during the year:

LOCKS AND DAMS.

Lock and Dam No. 1, Marietta.—All operations were for unforeseen repairs requiring immediate attention. They consisted in effectually closing a large leak under foundation of lock, with 40½ yards of rubblestone and 120 yards of gravel; removing 65 yards of mud deposit from mill race back of lock; removing the débris of a collapsed storehouse from lock yard, and tearing out remainder of old coffer from around upper end of river wall of lock, when, on account of the extreme low stage of water, the work was practicable.

The lock gates and irons on lock walls were repainted, and the lock, although incomplete, was successfully operated throughout the year.

Lock and Dam No. 2, Devols.—The old and badly worn stone coping on upper ends of both lock walls was taken up and replaced with 1,103 square feet of concrete, 1 foot thick, at a cost of 38 cents per square foot. Two thousand eight hundred and thirty-five square feet of the chamber faces of lock walls was repaired by cleaning and filling all cavities with concrete and pointing open joints.

The bank of mill race back of lock was refilled with 476 yards of earth, and a dry stone wall 105 feet in length was built to retain toe of fill.

The stem of one of the cylindrical valves became detached from valve and repairs were made after coffering valve recess with plank set on edge.

The lock gates and lock irons were repainted, an old and worthless shed was moved from lock yard, and minor repairs were made to lock house.

Lock and Dam No. 3, Lowell.—The old sheeting on 32 linear feet of dam was replaced with new timbers; several empty cribs of dam were refilled with stone and gravel, stone backing was placed along 425 feet of dam, to replace washed out material. Small amount of stone was filled into guiding crib below river wall of lock. New iron cover plates were made and fastened over both recesses for balanced valve machinery on lock walls.

A few yards of earth were placed on canal embankment at head of lock, where it had settled. The outer row of guide piling at bridge across upper end of canal was taken up and set back on line with rest pier of draw, and the storehouse, lock [illegible], and lock irons were repainted.

Lock and Dam No. 4, Beverly.—The guide crib below land wall of lock, 40 feet in length, was rebuilt from low-water level to a height of 5 feet below top of lock [illegible] and 125 yards of earth were placed back of this crib to complete terreplein of

The following materials were expended on crib:

White oak timber	feet, B. M..	8,753
[illegible]	cubic yards..	200
Bolts	pounds..	810

Piers were made to the canal bank at a point 200 feet above head of lock, the [illegible] being in a dangerous condition, owing to leakage through and around old head and conduit of abandoned mill. The gates and timbers of conduit were torn [illegible] loose material excavated down to a depth of 5 feet below level of upper pool; [illegible] in bank was then refilled with tight material and canal side of fill paved [illegible] ge stone to a height of 5 feet above level of upper pool.

[illegible] ng amounting to 90 yards of gravel was filled along back of dam where there [illegible] lence of leakage.

[illegible] ck and guard gates were repainted.

[illegible] d Dam No. 5, Lake Chute.—The guide crib below land wall of lock, 60 feet [illegible], was rebuilt.

[illegible] lowing materials were required for crib:

[illegible] timber	feet, B. M..	10,600
[illegible]	cubic yards..	310
[illegible]	pounds..	1,135

[illegible] walls were repaired with concrete and all open joints on chamber faces [illegible] were repointed.

A few square yards of the paving on embankment at upper end of lock were reset and lock gates repainted.

The stems of both cylindrical valves of lock became detached from valves; repairs were promptly made and there was no delay in the use of the lock on this account.

Extensive repairs were made to the lock-keeper's house; they consisted in rebuilding the four front rooms, rebuilding cellar walls, chimneys, and roof, and in repairing the walls of remaining old portion of house.

Lock and Dam No. 6, Stockport.—At the commencement of the fiscal year the middle portion of this dam, for a length of 234 feet, was in a dangerous condition, liable to fail at any time.

The project was to rebuild this section as a slope dam, in conformity with repairs made to dam in previous years, and thus secure a slope for the entire length of dam.

Work began in August and the dam was completed early in October. The materials used were purchased under proposals of ten days, and the work done by hired labor. The following amounts of material were expended:

White oak timber	feet, B. M..	200,178
Stone	cubic yards..	1,500
Driftbolts	pounds..	23,955

The cost of this work, including the placing of new backing along 483 feet of dam, was $6,323.03; deducting $239.03, the estimated cost of transporting and placing the backing, the cost per linear foot of new dam was $26.

Considerable filling has taken place along front of dam since its completion.

New cover plates were placed over both recesses for balanced valve machinery on lock, and new fender planking were fastened on the lock gates.

All the wood and ironwork connected with lock was repainted.

Lock and Dam No. 7, McConnelsville.—The stone portal and 8 feet of the brick arch at outlet of turbine culvert under carpenter shop was rebuilt. The timber posts under carpenter shop were replaced with concrete piers, and floor of this shop brought back to a uniform level.

The cross wall at head of land wall of lock was rebuilt; new cover plates for balanced valve machinery were made and placed on both lock walls, and the embankment between canal and river was refilled to its original height, with material taken from lock yard.

The old timbers on 65 feet of crest and 75 feet of second step of dam, were replaced with new timbers; all empty cribs of dam were refilled with stone and the backing along 150 feet renewed. The following amounts of material were expended on dam:

White oak timber	feet, B. M..	22,688
Stone	cubic yards..	300
Driftbolts	pounds..	1,400

The drawbridge at head of canal, belonging to the Government, was again made serviceable and easy to operate, by making a new iron circular track and timber turntable.

The guard and lock gates, machinery, and derricks in storehouse and yard, and drawbridge were repainted.

The spur dike below left abutment of dam, built during the previous year, was entirely completed by placing a few yards of stone shore protection around root of dike.

Lock and Dam No. 8, Eagleport.—The dam, for a distance of 50 feet out from the right abutment was refilled with stone and backed with stone and gravel. New cover plates were placed over both recesses for balanced valve machinery on lock walls.

The dike below right abutment of dam was completed by filling in and properly placing 2,200 yards of additional stone.

The lock gates and lock irons were repainted.

Lock and Dam No. 9, Taylorsville.—Repairs as projected were made to the dam, and have resulted in maintaining this work intact, although the ice during the past winter was gorged to a height of 10 feet over crest of dam.

During the working season of 1894, the worthless sheeting and longitudinal timbers along 125 feet of crest and 129½ feet of second step of dam were renewed; all empty cribs were refilled with stone, and the dam was well backed with tight material.

The following amounts of material were expended on dam:

White oak timber	feet, B. M..	21,805
Stone	cubic yards..	439
Driftbolts	pounds..	1,645

The masonry in outer guard gates abutment was repaired with 12 yards of concrete and coping reset.

All lock gates at this place were repainted.

Lock and Dam No. 10, Zanesville.—Repairs made to lock consisted in filling a cavity in land wall at upper end of middle gate recess with four yards of concrete; filling 5 yards of concrete into holes under and in spaces between timbers of lower miter sill to stop leakage, and replacing 186 square feet of stone coping with concrete.

The middle gates of combined lock were repaired and maintained in as good condition as was possible by inserting new timbers in decayed arms, fastening a few additional brace bars, and repairing valves and valve stems. These gates are almost worthless, and should be replaced at an early date.

The usual amount of work was necessary to keep lock chambers free from mud. The efficiency of the lock was much improved by the repairs made.

Operations on the dam were directed to resheeting top, and raising low places in crest to a uniform level. New longitudinal timbers were inserted and the crest resheeted for a distance of 123 feet; empty spaces in dam were refilled with stone, and repairs made to first and second step of dam at places where new sheeting was required.

The following amounts of material were expended on dam:

White oak timber	feet, B. M..	25,448
Stone	cubic yards..	400
Driftbolts	pounds..	1,734

BOATS.

The U. S. dredge *Malta* has been usefully employed during the year in maintaining good navigable depths in canals, approaches to locks, and over shoals in open river.

A large amount of the dredged material was deposited back of the various dams, thus aiding materially in stopping leakage through dams and maintaining the pools at their normal levels.

The dredge worked in channel from mouth of river to railway bridge and in upper approach to Lock No. 1, in approaches to locks at Nos. 2, 5, 6, and 8, in open river at Baldwins Ripple, pool No. 4, Silver Heels Ripple, pool No. 5, in channel 3 miles below Lock No. 7, at Gaysport Bridge, pool No 8, and in channel 2 miles below Lock No. 10. A channel was dredged from Lock No. 10 to the Sixth Street Bridge at Zanesville, a distance of 1,200 feet, and the canals at Nos. 3, 4, 7, and 10 were dredged.

The dredging during the fiscal year extended over a distance of 3.1 miles, or an average distance of 86.4 feet for each day while dredge was in commission.

The towing for the dredge during the season of 1894 was done by the hired steamboat *Lizzie Cassel;* from June 8 to 30, 1895, the steamer *Hazel Rice* was employed as tender for dredge.

Extensive repairs were made to machinery of dredge while in winter quarters at Zanesville.

The Government steamer *Vega* was engaged in transporting the material for repairs and supplies required at the locks and dams, and in acting as dredge tender for a part period.

The floating pile driver, one service barge, and one dump scow were docked and repaired.

BRIDGES.

Railroad bridge of the Baltimore and Ohio Southwestern Railroad Company at Marietta, —The plans and estimates for pivot pier with guard for new draw of this bridge having been approved by the Secretary of War, preparations were made for commencing operations. At the close of the fiscal year piling and timber for foundation were purchased, but had not yet been delivered.

Norwalk and Duncans Falls Bridge.—The project for building the pivot pier and cribs in the reconstruction of this bridge having been approved, preparations were made for commencing operations by inviting proposals for material required in construction.

Main Street Bridge at Zanesville.—Nothing has been done toward altering this bridge.

Fifth Street Bridge at Zanesville.—The removal of piers to a depth of 7 feet below normal level of pool was completed September 1, 1894, in compliance with extension of time for such removal granted by the Secretary of War.

LAND.

Zanesville and Ohio River Railway, through a mistake as to ownership, runs without authority across the Government land at No. 7, Malta, Ohio. No effort to secure the right of way from the United States has as yet been made.

No leases for land or water power were issued.

PROTECTION WALL AT ZANESVILLE, OHIO.

This work was in pursuance of an item in the sundry civil act, approved March 2, 1895, providing for an expenditure not to exceed $2,500 to rebuild or repair a protection wall on west bank of Muskingum River, about 100 feet north of the Main Street Bridge at Zanesville, Ohio.

A part of the wall in question had failed during the past winter and the remainder was worthless and inadequate to long sustain the earth pressure back of it. A project for rebuilding the wall was therefore submitted, and, upon approval, a contract was entered into with J. C. Williams, of Zanesville, Ohio, for construction of a retaining wall 70 feet in length upon site of old protection wall.

The wall was built of rock-faced ashlar, laid in regular horizontal courses, and was finished with a parapet 2 feet wide and 3 feet high; height of wall from top of footing to top of coping is 17 feet; thickness at base, 5 feet 8 inches, and at top or surface of backing, 2 feet 4 inches; thickness of footings is 7 feet.

Work was commenced April 20, 1895, and the wall was completed in June.

The following materials were expended:

Excavation	cubic yards..	376
Concrete	do....	14
Masonry	do....	191½

The cost of the work was $1,086.94.

Muskingum River leases.

YEAR ENDING APRIL 30, 1895.

Location.	Lessee.	Dated.	Expires.
Dam No. 1, Marietta	Phœnix Mill Co	May 1, 1873	May 1, 1903
Dam No. 2, Devols	Gates & Payne	May 1, 1889	May 1, 1909
Dam No. 3, Lowell	Milton King	May 1, 1890	May 1, 1910
Do	F. Wilking & Co	do	Do.
Do	Rechsteiner Bros	do	Do.
Do	do	Nov. 1, 1892	Nov. 1, 1912
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Do	George Rice	Sept. 1, 1889	Sept. 1, 1909
Dam No. 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	George S. Worstell	May 1, 1890	May 1, 1910
Do	Mary L. Baldwin	do	Do.
Do	D. T. Brown	do	Do.
Do	Isaac D. Spooner	do	Do.
Dam No. 6, Stockport	Joseph Newberry	May 1, 1889	May 1, 1909
Dam No. 7, McConnelsville	E. M. Stanberry	Sept. —, 1839	
Dam No. 9, Duncans Falls	John Miller	Dec. 31, 1836	
Dam No. 9, Taylorsville	Frazier & Son	do	
Do	R. W. Huff	May 1, 1894	May 1, 1899
Dam No. 10, Zanesville	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson	do	Do.
Do	do	May 1, 1889	Do.
Do	Muskingum Coffin Co	May 1, 1890	Do.
Do	Gary & McLaughlin	do	Do.
Do	T. L. Moorehead	May 1, 1893	May 1, 1913
Symmes Creek	Sarah V. Plummer	May 1, 1894	May 1, 1909

YEAR ENDING MAY 31, 1895.

Dam No. 10, Zanesville	John Blankenbuhler	June 1, 1892	June 1, 1909
Do	Frederick Abel	do	Do.

Leases—Water power, land, and rental.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate.	Rents collected.
Phœnix Mill Co	Water power	3,000	$350.00	$56.22	$293.78
Gates & Payne	do	9,000	108.00		108.00
Milton King *	do	2,600	100.00		
F. Wilking & Co	do	7,280	174.72		174.72
Rechsteiner Bros	do	4,446	106.70		106.70
Do	Land		10.00		10.00
E. W. Sprague	do		5.00		5.00
George Rice	do		6.00		6.00
Robbins Bros. †	Water power	1,904	100.00		
George S. Worstell ‡	do	5,600	114.24		114.24
Mary L. Baldwin	do	5,000	100.00		100.00
D. T. Brown	do	6,500	118.30		118.30
Isaac D. Spooner	do	4,000	100.00		100.00
Joseph Newberry	do	6,390	230.04	41.83	188.21
E. M. Stanberry §	do	(‖)			
John Miller §	do	(¶)			
Frazier & Son §	do	(¶)			
R. W. Huff	Land		17.00		17.00
John T. Drone	Water power	7,560	453.60		453.60
Edward Johnson	do	6,029	361.74		361.74
Do	do	7,399	443.82		443.82
Muskingum Coffin Co	do	4,619	207.86		207.86
Gary & McLaughlin	do	4,794	186.96		186.96
T. L. Moorehead	Land		25.00		25.00
Sarah V. Plummer	do		5.00		5.00
John Blankenbuhler	Water power	2,700	100.00		100.00
Frederick Abel	do	5,200	184.50		184.50
Total					3,310.43

* Lessee insolvent; water shut off.
† No collection.
‡ Lease transferred to Langenburg & Abrams, April 30, 1895.
§ Perpetual free lease of water power.
‖ Enough to propel 10 run of 4 foot 5 inch millstones.
¶ Enough to propel 15 run of 4½-foot millstones.

Detailed statement of expenses incurred on Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1895.

GENERAL ADMINISTRATION.

Month.	Salaries.		Plant.						
	Office force.	Lock keepers, bridge tender, gauge reader, and watchman.	First cost.	Repairs.	Repair of buildings.	Supplies.	Transportation.	Miscellaneous.	Total.
July	$555.00	$649.00	$2.13	$1.05	.....	$15.06	$20.02	$77.35	$1,319.61
August	430.00	649.00	34.94	10.25	.....	43.22	5.70	54.35	1,227.46
September	478.00	649.00	.....	15.25	.....	6.82	6.65	44.39	1,200.11
October	470.00	649.00	.88	14.00	.....	54.00	3.85	84.55	1,276.28
November	545.00	649.00	5.20	2.15	.....	15.46	3.00	37.95	1,257.76
December	570.00	649.00	.35	.....	.....	18.62	.38	39.26	1,277.61
January	445.00	649.00	.....	.....	$6.25	8.72	.....	32.05	1,141.02
February	540.00	649.00	.....	.....	.....	6.17	.....	32.55	1,227.72
March	575.00	649.00	.....	.....	.....	39.69	.....	31.89	1,295.58
April	570.00	649.00	20.99	.50	.....	98.31	11.62	33.60	1,384.02
May	575.00	649.00	.....	81.53	389.47	7.06	.....	43.11	1,745.17
June	540.00	649.00	.....	166.12	240.79	3.15	34.03	33.45	1,666.54
Total	6,293.00	7,788.00	64.49	290.85	636.51	316.28	85.25	544.50	16,018.88

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

U. S. DREDGE MALTA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Towboat.	Total.
July	$504.25	.....	$49.44	$31.57	$598.00	$1,183.26
August	481.73	.....	44.00	83.94	621.00	1,230.67
September	494.79	.....	59.11	.....	575.00	1,128.90
October	507.33	$55.72	53.84	15.41	621.00	1,253.30
November	475.70	.....	39.50	25.50	598.00	1,138.70
December	525.44	8.13	15.00	5.00	.....	553.57
January	149.44	1.25	.....	.....	.....	150.69
February	100.00	.....	1.00	.....	.....	101.00
March	100.00	30.00	.....	152.50	.....	282.50
April	233.38	46.16	.....	116.37	.....	395.91
May	256.00	.....	18.00	299.50	.....	573.50
June	529.64	.....	22.00	140.88	437.00	1,129.52
Total	4,357.70	141.26	301.89	870.67	3,450.00	9,121.52

U. S. STEAMER VEGA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Total.
July	$383.96	.....	$21.21	.....	$405.17
August	360.38	$3.31	31.20	$7.07	401.96
September	357.50	.....	22.95	1.92	382.37
October	360.38	.....	24.35	12.50	397.23
November	326.00	.....	20.12	4.94	351.06
December	345.62	.....	10.72	.....	356.34
January	62.88	.....	.....	.....	62.88
February	60.00	.....	.....	.....	60.00
March	60.00	22.98	.....	.....	82.98
April	77.28	.....	.....	48.54	125.82
May	266.58	.....	18.46	10.31	295.35
June	315.38	.....	20.70	9.24	345.32
Total	2,975.96	26.29	169.71	94.52	3,266.48

LOCK AND DAM NO. 1.

Month.	Labor.	Material.	Supplies.	Total.
August	$50.58	$79.97	.....	$130.55
September	15.48	2.75	.....	18.23
October	.....	2.00	$3.06	5.06
Total	66.06	84.72	3.06	153.84

LOCK AND DAM NO. 2.

August	$7.20	$78.26	.....	$85.46
September	174.54	31.31	.....	205.85
October	400.74	31.61	$10.50	442.85
November	156.52	.....	.....	156.52
March	5.76	.....	.....	5.76
June	59.96	.....	.....	59.96
Total	804.72	141.18	10.50	956.40

LOCK AND DAM NO. 3.

July	.....	.....	$3.38	$3.38
August	$38.94	$7.01	.....	45.95
September	84.99	31.32	.....	116.31
October	40.70	90.02	8.14	138.86
January	.72	52.50	.....	53.22
April	7.20	.....	.....	7.20
May	11.10	.....	.....	11.10
June	3.73	.....	.....	3.73
Total	187.38	180.85	11.52	379.75

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 4.

Month.	Labor.	Material.	Supplies.	Total.
July	$4.86			$4.86
August	121.63	$7.01		128.64
September	186.64	2.75		189.39
October	158.88	188.36	$8.03	355.27
November	39.88		2.00	41.88
January	11.34			11.34
March	8.64			8.64
May	2.16			2.16
Total	534.03	198.12	10.03	742.18

LOCK AND DAM NO. 5.

August		$78.26		$78.26
September		2.75		2.75
October	$168.79	155.82	$8.03	332.64
November	132.32	78.00		210.32
December	38.38	43.21		81.59
Total	339.49	358.04	8.03	705.56

LOCK AND DAM NO. 6.

August	$1,217.43	$454.20	$12.50	$1,684.13
September	1,379.58	18.80	30.00	1,428.38
October	255.74	2,476.55	19.11	2,751.40
November		450.00		450.00
December	9.12			9.12
January		52.50		52.50
May	20.16			20.16
June	8.64			8.64
Total	2,890.67	3,452.05	61.61	6,404.33

LOCK AND DAM NO. 7.

July			$1.00	$1.00
August	$46.24	$7.01		53.25
September	62.64	281.85		344.49
October	86.58	129.32	2.97	218.87
November	180.72			180.72
December	195.02			195.02
January		52.50		52.50
March	12.66			12.66
April	53.17			53.17
May	21.90			21.90
Total	658.93	470.68	3.97	1,133.58

LOCK AND DAM NO. 8.

uly	$46.36		$5.00	$50.36
ugust	64.02	$12.29		76.31
eptember	348.34	5.00	.88	354.22
ctober	20.16	111.30	3.05	134.51
ovember	2.88			2.88
anuary		52.50		52.50
arch	2.88			2.88
pril	9.80			9.80
Total	493.44	181.09	8.93	683.46

LOCK AND DAM NO. 9.

ugust		$78.26		$78.26
ptember	$328.84	263.32		592.16
tober	76.64	173.41	$3.03	253.08
arch	8.64			8.64
Total	414.12	514.99	3.03	932.14

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 10.

Month.	Labor.	Material.	Supplies.	Total.
July	$4.50			$4.50
August	212.14	$108.26	$1.45	321.85
September	219.36	346.04		565.40
October	120.81	8.49	3.06	132.36
November	33.62	165.75		199.37
December	3.78	.96		4.74
March	17.54			17.54
April	10.08			10.08
May	32.40			32.40
June	64.71			64.71
Total	718.94	629.50	4.51	1,352.95

SUMMARY.

General administration	$16,018.88	Lock and Dam No. 6	$6,404.33
U. S. dredge *Malta*	9,121.52	Lock and Dam No. 7	1,133.58
U. S. steamer *Vega*	3,266.48	Lock and Dam No. 8	683.46
Lock and Dam No. 1	153.84	Lock and Dam No. 9	932.14
Lock and Dam No. 2	956.40	Lock and Dam No. 10	1,352.95
Lock and Dam No. 3	379.75	Total	41,851.07
Lock and Dam No. 4	742.18		
Lock and Dam No. 5	705.56		

Detailed statement of expenses incurred in building protection wall on west bank of Muskingum River, below Dam No. 10, Zanesville, Ohio, for the fiscal year ending June 30, 1895, to wit:

191.75 cubic yards masonry, at $4.23	$811.10
14 cubic yards concrete, at $3.25	45.50
376 cubic yards excavation, at 12½ cents	47.00
1 1/3 months' services of subinspector, at $100	183.34
Total	1,086.94

Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1895.

Date.	Locality.	Material excavated.	Total cost.
July	Lowell, Ohio	4,220 yards gravel, sand, and mud, at 8 cents	$337.60
	Beverly, Ohio	3,010 yards gravel, stone, and mud, at 10 cents	301.00
	Zanesville, Ohio	8,365 yards gravel, sand, and mud, at 6 cents	501.90
	do	1 stone, 4 tons	21.76
	Pool No. 9	12 logs, at 50 cents	6.00
	do	3 snags, at $5	15.00
August	Zanesville, Ohio	6,300 yards gravel, sand, and mud, at 6 cents	378.00
	Pool No. 9	4 logs, at 50 cents	2.00
	Taylorsville, Ohio	1,200 yards gravel, sand, and mud, at 9 cents	108.00
	do	1 snag	5.00
	Gaysport, Ohio	1,900 yards gravel, sand, and mud, at 10 cents	190.00
	do	15 logs, at 85 cents	12.75
	do	1 snag	5.00
	do	1 stump	5.92
	3 miles below McConnelsville, Ohio.	1,600 yards gravel, sand, and mud, at 10 cents	160.00
	do	6 snags, at $3	18.00
	Stockport, Ohio	3,400 yards gravel, sand, and mud, at 10 cents	340.00
	Silver Heels Ripple	20 stones, at 30 cents	6.00
September	Luke Chute, Ohio	1,460 yards rock and gravel, at 10 cents	146.00
	do	30 stones, at 30 cents	9.00
	do	4 logs, at 50 cents	2.00
	do	1 snag	2.30
	do	40 linear feet cofferdam, at 50 cents	20.00
	do	2 pieces dam, at $10	20.00
	Baldwins Ripple	8,380 yards gravel, sand, and mud, at 8 cents	670.40
	do	4 stones, at 50 cents	2.00
	do	3 snags, at $2	6.00
	Beverly, Ohio	3,140 yards gravel, sand, and mud, at 8 cents	251.20

Detailed statement and cost of dredging on the Muskingum River, etc.—Continued.

Date.	Locality.	Material excavated.	Total cost.
October	Marietta, Ohio	4,100 yards gravel and stone, at 11 cents	$451.00
	do	42 logs, at 50 cents	21.00
	do	4 stumps, at $5	20.00
	do	2 trees, at $3	6.00
	do	1 piece of dam	19.30
	Lowell, Ohio	2,750 yards gravel, sand, and mud, at 8 cents.	220.00
	Beverly, Ohio	5,500 yards gravel, sand, and mud, at 9 cents.	495.00
	do	6 pieces piling, at $3	18.00
	do	2 timber sills, at $1.50	3.00
November	Devols Dam, Ohio	4,100 yards stone and gravel, at 8 cents	328.00
	do	4 logs, at $1	4.00
	do	2 stones, at $1	2.00
	Lowell, Ohio	2,300 yards gravel, sand, and mud, at 8 cents.	184.00
	McConnelsville, Ohio	3,190 yards gravel, sand, and mud, at 10 cents.	319.00
	Eagleport, Ohio	1,300 yards gravel, sand, and mud, at 10 cents.	130.00
	do	1 piece of cofferdam	16.70
	do	32 pieces sheet piling, at 50 cents	16.00
	Zanesville, Ohio	1,390 yards gravel, sand, and mud, at 10 cents.	139.00
December	do	6,315½ yards gravel, sand, and mud, at 7 cents.	442.07
	do	1,115 yards stone and gravel, at 10 cents	111.50
January		Repairs on dredge	150.69
February		do	101.00
March		do	282.50
April		do	395.91
May		do	573.50
June	Zanesville, Ohio	6,684½ yards gravel and mud, at 16 cents	1,069.50
	do	45 linear feet cofferdam, at $1	45.00
	do	2 logs, at $1	2.00
	do	2 stumps, at $6.50½	13.01
	Total		9,121.51

COMMERCIAL STATISTICS.

Commerce of Muskingum River during the calendar year ending December 31, 1894.

LOCK NO. 1.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	25	10	4	39	39
February	50	21	1	72	72
March	66	70	18	154	154
April	73	115	11	199	199
May	69	45	20	134	134
June	70	53	28	151	151
July	85	26	17	128	128
August	90	28	4	122	122
September	54	43	5	102	102
October	84	49	16	149	149
November	78	63	14	155	155
December	78	45	9	132	132
Total	822	568	147	1,537	1,537

LOCK NO. 2.

January	22	7	.....	29	29
February	44	4	.....	48	48
March	55	14	3	72	72
April	54	10	1	65	65
May	61	12	8	81	81
June	73	18	7	98	98
July	87	15	3	105	105
August	84	12	3	99	99
September	51	11	3	65	65
October	68	15	4	87	86
November	49	33	3	85	85
December	52	10	.....	62	62
Total	700	161	35	896	895

Commerce of Muskingum River during the calendar year, etc.—Continued.

LOCK NO. 3.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	20	5	3	28	27
February	42	2	1	45	44
March	55	4	3	62	62
April	54	7	1	62	58
May	61	9	3	73	73
June	58	14	7	79	74
July	69	9	8	86	83
August	71	2	7	80	80
September	50	11	5	66	66
October	75	21	10	106	98
November	50	26	11	87	89
December	52	10	1	63	61
Total	657	120	60	837	809

LOCK NO. 4.

January	7	.....	.....	7	7
February	4	1	.....	5	4
March	5	5	5	15	15
April	5	2	3	10	10
May	41	5	4	50	48
June	42	14	5	61	56
July	31	11	.....	42	41
August	22	4	5	31	23
September	27	8	1	36	33
October	48	33	6	87	74
November	43	24	2	69	69
December	33	6	3	42	40
Total	308	113	34	455	411

LOCK NO. 5.

February	4	1	1	6	5
March	1	.....	1	2	2
April	6	.....	.....	6	6
May	51	21	5	77	78
June	40	26	17	83	83
July	26	6	16	48	43
August	21	5	7	33	37
September	53	11	4	68	65
October	41	9	11	61	56
November	32	8	8	48	43
December	29	5	3	37	37
Total	304	92	73	469	455

LOCK NO. 6.

January	2	2	.....	4	4
February	4	.....	2	6	5
March	1	.....	2	3	3
April	6	1	24	31	31
May	37	3	12	52	50
June	43	14	39	96	95
July	21	18	34	73	63
August	26	31	29	86	77
September	40	61	12	113	109
October	42	17	11	70	65
November	37	15	7	59	53
December	29	4	1	34	36
Total	288	166	173	627	589

Commerce of Muskingum River during the calendar year, etc.—Continued.

LOCK NO. 7.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
February	4	1	.....	5	4
March	2	.....	2	4	4
April	9	11	9	29	29
May	41	6	5	52	47
June	42	31	20	93	86
July	21	7	30	58	54
August	23	5	27	55	48
September	41	11	6	58	52
October	39	2	11	52	49
November	35	4	10	49	45
December	25	2	2	29	29
Total	282	80	122	484	447

LOCK NO. 8.

February	7	1	.....	8	7
March	57	.....	12	69	69
April	55	.....	12	67	67
May	93	6	7	106	102
June	89	5	8	102	101
July	95	8	15	118	117
August	91	10	13	114	110
September	102	19	8	129	116
October	94	1	7	102	101
November	86	10	11	107	103
December	71	.....	2	73	73
Total	840	60	95	995	966

LOCK NO. 9.

February	7	1	.....	8	7
March	56	6	6	68	67
April	55	3	9	67	66
May	95	5	16	116	110
June	91	.....	32	123	121
July	104	8	58	170	148
August	94	8	29	131	123
September	91	9	18	118	113
October	93	2	10	105	98
November	87	12	9	108	96
December	71	6	.....	77	74
Total	844	60	187	1,091	1,023

LOCK NO. 10.

January	.....	.....	1	1	1
February	7	.....	1	8	8
March	57	.....	.....	57	57
April	58	.....	1	59	59
May	90	8	.....	98	93
June	85	1	.....	86	86
July	122	26	2	150	145
August	99	6	1	106	105
September	85	3	.....	88	88
October	86	2	1	89	87
November	76	4	.....	80	77
December	71	149	1	221	220
Total	836	199	8	1,043	1,026

Commerce of Muskingum River during the calendar year, etc.—Continued.

SUMMARY.

Lock No. —	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
1	822	568	147	1,537	1,537
2	700	161	35	896	895
3	657	120	60	837	880
4	308	113	34	455	411
5	304	92	73	469	423
6	288	166	173	627	580
7	282	80	122	484	447
8	840	60	95	995	968
9	844	60	187	1,091	1,023
10	836	199	8	1,043	1,036
Total	5,881	1,619	934	8,434	8,108

List showing amount of principal items of freight and the number of passengers carried on the Muskingum River, for the calendar year ending December 31, 1894.

Articles.	Amount.	Articles.	Amount.
Passengers.....number..	49,892	Wool.....tons..	282
General merchandise.....tons..	8,067	Lumber.....do...	17,040
Coal.....do...	9,287	Brick.....do...	2,838
Live stock.....do...	503	Hay.....do...	620
Oil.....do...	3,925	Salt.....do...	725
Wheat.....do...	3,650	Potatoes.....do...	528
Corn.....do...	3,642		

List of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio.

Name.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Inches.*	
Hazel Rice	126	22.5	4	26	137.62
Lizzie Cassel	138	31.5	4.5	22	176
T. M. Bayne	120	24	3.5	20	115
Sonoma	125	20	3.5	23	116
Ida Smith	111	18	2.5	17	44.14
Water Maiden	69	12	2.5	24	24
Emma	76	14	2.5	26	25
Mary H	113	18	3.9	22	62
Del Norte	35.4	8.2	4.4	40	5.34
D. T. Watson*	99	17	2.5	36	80.45
Valley Belle*	127	22	3.5	27	127.48
Mary E.*	80	18.5	3	30	19.34
Ada V.*	82	13.5	2	20	21.82
T. N. Barnsdall*	130	26	4	26	127
Lyda H.*	115	20	3.5	20	100
Jim McConnell*	120	24	3.5	30	125

* Only occasional trips on the Muskingum River.

C C 8.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

At the close of the last fiscal year there was a balance available to the credit of this work of $324.96. Two barges of coal having been wrecked at Phillisi Island on January 21, one of which lay broadside

across the channel, the Pittsburg Coal Exchange, pending action by this office, obtained written abandonment from the owners and employed a steamboat, which removed the barge obstructing the channel. The facts were reported to the Chief of Engineers in letter dated February 8, 1895, and authority granted for payment of the expense incurred.

C C 9.

PRELIMINARY EXAMINATION AT IRONTON, OHIO, WITH A VIEW OF PROTECTING THE OHIO RIVER FRONT WITHIN THE LIMITS OF THE CITY.

[Printed in House Ex. Doc. No. 212, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 15, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 12, 1895, by Lieut. Col. Amos Stickney, Corps of Engineers, of the results of a preliminary examination at Ironton, Ohio, "with a view of protecting the Ohio River front within the limits of the city," made to comply with the provisions of the river and harbor act of August 17, 1894.

It is the opinion of Lieutenant-Colonel Stickney, concurred in by this office, that the locality is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 12, 1895.

GENERAL: I have the honor to submit the following report upon an examination made at "Ironton, Ohio, with a view of protecting the Ohio River front within the limits of the city," in accordance with the requirements of act of Congress of August 17, 1894.

Upon the 19th of September, 1894, my assistant, First Lieut. William C. Langfitt, Corps of Engineers, U. S. A., made a personal examination of the locality. At that time, the stage of the river being comparatively low and the parties interested being of the belief that a higher stage would develop a different state of the case, it was decided to make a second examination when the river should have risen to a higher stage. The second visit was made January 9, 1895. A copy of the report of Lieutenant Langfitt is herewith.

It appears from the investigation that there is a slow erosion of the river bank at the locality, but that it is not serious, and it is not occasioned by any Government work, nor is it of a nature to affect the navigable condition of the river. It has not been the practice for the General Government to expend public funds to prevent the wearing away of banks of rivers solely for the protection of municipal or indi-

vidual property where there was no question relating to general nav gation, except, perhaps, in cases where many and large interests wer involved and the threatened destruction of property was of suc extent as to require remedial measures at a cost beyond the ability c the owners of the property.

In this case it would seem that there is no question relating to th general navigation of the river, and that a small amount of bank cov ering of any material that would not wash away, and which would no cost an excessive amount, would fully cover the needs of the case; an it does not seem to be a matter in which the General Government woul be justified in undertaking the work. I am therefore of the opinio expressed by Lieutenant Langfitt that the improvement is not on worthy to be made by the General Government.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF FIRST LIEUT. WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 11, 1895.

COLONEL: In accordance with your instructions, I made an examination at "Ironton, Ohio, with a view of protecting the Ohio River front within the limits of the city," on September 19, 1894, and again on January 9, 1895, and have the honor to submit the following report thereon.

An examination of this place for the purpose stated is required by the river and harbor act of August 17, 1894.

The city of Ironton, Ohio, lies on the right bank of the Ohio River, the public landing being about 325 miles below Pittsburg. The city limits extend upstream to near the mouth of Ice Creek and downstream to a point some three-fourths of a mile below the mouth of Storms Creek, the total river front within the city limits being thus about 4 miles in length, all of which I examined.

Except where artificial protection has been applied the following general description may be taken as applicable to any point of the river bank within the city limits at the low stage existing at my first visit.

From the water's edge the bank rises gradually for a distance back of some 200 feet, more or less, reaching an elevation in that distance of some 35 feet or more. This is followed by a much steeper portion some 20 feet or more in height. These figures are of course only approximations and vary from point to point. At the foot of the steeper portion, and extending toward the water's edge, willows and bushes of various kinds are growing, which tend to protect the banks. Along this river front at varying distances apart are iron works and furnaces, sawmills, brick works, etc., in rear of which the bank has been protected more or less by dumping the waste products of the manufactories in question. Where these products are slag from iron furnaces the protection is complete, and in some cases this slag has been used in rear of other works also. Much ground has in this way been built up, the built-up portion extending out in many cases like a promontory in front of the general high bank line. Where protection has been applied no signs of erosion are visible. Everywhere else, on the contrary, the high bank shows signs of a general recession, due to caving caused by high water.

The river front of the city extends along a portion of the concave bank of a very gentle bend in the river. From appearances and from information obtained it would seem that the amount of caving per year is, generally speaking, small in amount and will continue so. The most effective cause of this erosion is said to be the presence of a layer of sand, some 2 feet thick, found at about 20 feet below the top of the high bank, this sand being washed out in high water, followed by a caving of the portion of the bank above it.

In view of the fact that the caving is small in amount and is confined to the upper portion of the high bank, its continuance, though distressing to the owners of the property, can have no possible influence on the channel in the front of the city, or

affect in any way the approach to its landing. So far as navigation interests are concerned, there is, then, no necessity whatever for protecting these banks.

I was informed by a member of the council of Ironton that that body had, through the Member of Congress for that district, caused the introduction of the clause directing this examination. The council had in view the protection of the bank at two points, where, it is stated, the caving has been more rapid than elsewhere.

The first point is the portion of the city front lying below Storms Creek. On the upstream angle formed by this creek and the Ohio River are located the works of the New York and Ohio Iron and Steel Company, locally known as the Ironton Furnace. From continual dumping of slag and other furnace refuse there has been built up a high point projecting considerably beyond the general high bank line, and those interested claim that this point causes an eddy below and behind it at high water, through which agency the erosion and caving have been materially increased.

The second place had in view by the council covers a length of about two blocks, or about 700 feet, and extends from the upper end of the city's paved landing up to near the city waterworks. Here the caving is particularly to be regretted, as it is destroying a small and, in fact, the only park owned by the city. In 1888 the United States erected two ice breakers at this city. They are located in front of the city waterworks property; that is, about 75 feet above the upper end of the caving bank and park. It was stated on my first visit, and is believed by those interested, that the presence of these ice breakers, perhaps by causing an eddy below them in high water, has accelerated the rate of caving over the park front. The waterworks front has been protected by a deposit of broken slag and cinders, and but little caving has taken place. The property owners above and adjoining the waterworks property have built out their property until it projects considerably beyond the former, and whose bank line is, at the bottom, within about 40 feet of the inner ice breaker. The ice breakers are each 24 feet in width and have a clear space between them of 36 feet.

In view of the belief of the parties interested, it was decided to make a second examination at a higher stage, when the presence of the eddy, should such exist, would certainly be apparent. This second examination was made as stated on January 9, 1895, the stage of river at Ironton being about 33 feet above low water and within 2 feet of the top of the outer breaker.

The mayor of the city, the president of the council, and one or two other members of that body, went with me to the site of the caving below the breakers. It was admitted by all present that no eddy existed, the current, though lessened in intensity, following along the bank without the slightest indication of any counter current or eddy effect. This was to be expected, as, through the spaces left between the breakers and between the inner one and the bank, the water passes in sufficient quantity to prevent the formation of an eddy. In fact, the general impression given to me was that the breakers, through their slackening effect on the current, exercised a more or less protecting effect.

Of course, at very high stages, say 40 to 50 feet, when the breakers are completely overtopped, this effect would be much less, and the upper or caving portion of the bank would be exposed to full effect of the caving tendencies of a concave bank. And it seems to be clear that all the caving, some 30 feet since 1888, the date of the erection of the breakers, that has taken place at this point is due to exactly the same causes as that produced elsewhere in the city limits, and that the breakers have had no effect whatever in increasing it. This conclusion is confirmed by the fact that the map of the survey made before the erection of the breakers shows that the high bank line along this portion had already retreated considerably as compared with the waterworks property which was protected. The necessity for protecting this latter property arose shortly after the erection of the waterworks in 1871, and I was informed these works were saved only by persistent effort in protecting the bank.

I also reexamined the portion below Storms Creek and could observe no eddy effect at all injurious to the banks, and I was confirmed in the conclusion already stated, that none of the caving taking place here or elsewhere is injurious to navigation interests, nor has it been produced or accelerated by any action of the General Government.

In view of all the facts stated, I have to report that, in my opinion, the locality is not "worthy of improvement by the General Government" so far as the question of protecting its river front is concerned.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut., Corps of Engineers.

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.

of the points of intersection of these lines and the middle line of the dike were ascertained by means of the level.

The lower portion of the Evansville wharf was found to be covered with a deposit of mud, cinders, etc. Lines of cross section 100 feet apart were run over this portion.

The stage of water was favorable at the time of making the survey. During the time when the soundings and cross sections were made the stage was from 1.7 feet to 0.7 foot above low water, low water being taken as 0.1 foot on the gauge at Evansville.

Just above the dike the river is wide and shoal. Abreast of the dike the bank on the Indiana shore is caving. The bank is composed of clay overlying sand. The water being forced over to this side by the dike, the sand is washed out and the clay breaks off and falls into the river.

The sand bar in front of the city has increased to such dimensions and contracted the low-water channel to such an extent that at the time of making the survey, when the water was at a low stage boats had difficulty in turning unless they were backed down below the bar.

The deposit of mud, cinders, etc., on the city wharf is a source of annoyance to the wharf-boat managers, as its presence compels them to spar their boats some distance out during the lower stages of the river and construct footbridges for the accommodation of persons desiring to pass to and from the shore.

A map of the harbor, in two sheets, is submitted herewith.

Very respectfully, your obedient servant,

J. NELSON CALDWELL,
Assistant Engineer.

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.

C C 11.

SURVEY OF MUSKINGUM RIVER, OHIO, FROM ZANESVILLE TO DRESDEN.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, February 27, 1895.

GENERAL: I have the honor to submit the following report of a survey of the Muskingum River from Zanesville to Dresden, with a view to its improvement, made in compliance with the requirements of the river and harbor act of August 17, 1894.

The survey was made under the supervision of Mr. Edmund Moeser, assistant engineer, a copy of whose report is appended, accompanied by two maps, one showing the river from Zanesville to Dresden, and the other the vicinity of the proposed lock and dam, which would be No. 11 of the Muskingum River series.

The object of this improvement is to extend the navigation of the river to Dresden, at which point connection would be made with the Ohio Canal, thus forming a through route of navigation from Lake Erie at Cleveland to the Ohio River at Marietta. From the information gained by this survey it is ascertained that to provide navigation to Dresden with channel not less than 6 feet in depth, one lock and dam will be required with a lift of about 11 feet. This would form a pool extending to Dresden, with about 7 feet of water on the lowest miter sill of the Ohio Canal locks at that place.

The location of the lock and dam should be near the bridge of the Cincinnati and Muskingum Valley Railway, a bridge about 8 miles above Zanesville which will require some alteration if the river is improved.

The estimate of cost of the lock and dam is stated by Mr. Moeser at $97,600, but on account of the probability of some small damage to be paid for overflow of land below Symmes Creek, and some dredging necessary below the site selected for the lock, and to provide for con-

tingencies, I would estimate the cost at $110,000. This does not include any cost of altering the bridge of the Cincinnati and Muskingum Valley Railway, as it is assumed that the railway company must make such changes as are necessary for navigation at its own expense.

The only available commercial statistics on this reach of river are stated in Mr. Moeser's report as 6,000 tons of freight per year.

For detailed information attention is invited to Mr. Moeser's report.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. EDMUND MOESER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, February 26, 1895.

SIR: I have the honor to submit the following report of a survey of the Muskingum River from Zanesville to Dresden, made in obedience to your order of November 8, 1894.

The report is accompanied by two maps; one showing the whole stretch of river between Zanesville and Dresden, and one the result of a special survey in the vicinity of the railway bridge across the river about 8 miles above Zanesville.

The field work was begun on November 17, 1894, and with the exception of the special survey was finished on January 10, 1895.

Beginning at Dam No. 10, at Zanesville, base lines aggregating 81,000 feet in length were carefully measured and oak hubs, suitably marked, set at the 1,000 feet stations or at points where deflections in the transit line occurred.

The initial base line at Zanesville was connected with lines of survey of canal and river below Dam No. 10, made in December, 1892, thereby lengthening stretch of river plotted a distance of 4,400 feet.

A line of levels was carried from Zanesville to Dresden and checked on permanent bench marks on canal lock at Dresden and at two intermediate points. Bench marks were established at the 1,000 feet stations on base lines.

Cross sections of the river and banks between high-water lines of 1884 were taken on lines 1,000 feet apart, over the whole stretch of river surveyed. Intermediate lines of soundings 200 feet apart were run in for some distance above and below the proposed site for lock and dam.

The high-water lines of February, 1884, were traced on the ground, and the low-water slopes were determined from the low-water readings of three gauges read during continuance of survey. All bridges, islands, bars, and other prominent features within the limits of the survey were located by triangulation.

In addition to the permanent gauge at Dam No. 10 two gauges were established—one at Dresden, and one at the railway bridge, 8 miles above Dam No. 10, and records of the readings kept for a period of forty-five days. The zeros of these gauges were connected by levels. All soundings and elevations were referred to mean sea level in conformity with datum used on the Muskingum River.

BORINGS.

The boring apparatus consisted of a set of 1-inch gas pipes in lengths of 6 feet, with couplings, several pieces of 4-inch pipe for casing, sand pumps, drills, and a timber pipe-driver. Steel points were forged to two pieces of the 1-inch pipe. The river being frozen over at the time no great difficulty was experienced in taking borings through the ice.

In order to determine nature of foundation at proposed site for lock and dam, and character of bed of river where deepening of the channel is desirable, borings were made on the sounding lines from stations 380 to 480, a distance of 10,000 feet, with the following result:

From stations 390 to 400 rock was found on right side of river at a depth of 19 feet below the level of Pool No. 10; from stations 410 to 450 the borings show sand, gravel, and bowlders to a depth of 24 feet below pool level on right side of river, and shale rock, covered with a thin layer of gravel, at a depth of 6 feet below pool level on left side. As the location of this rock is such that it is not available for founding a lock, nor is deepening of the channel desirable on this side of the river,

holes were drilled into the rock to a depth of 2 feet only. From stations 450 to 480 the borings across river again show sand, gravel, and bowlders to a depth of 24 feet.

DESCRIPTION OF RIVER FROM ZANESVILLE TO DRESDEN.

The Muskingum River is formed by the Tuscarawas and Walhounding rivers, 16 miles above Dresden, Ohio.

The distance by river from Dam No. 10, at Zanesville, to the flight of locks leading from the Ohio Canal to the Muskingum River at Dresden, is exactly 15 miles, the fall of the low-water surface being 9.95 feet.

The Cleveland, Canton and Southern, and the Cincinnati and Muskingum Valley railways follow the right and left banks of the river from Zanesville to a point 8 miles above, where the Cincinnati and Muskingum Valley Railway crosses to the right bank; both roads then follow the right bank to Dresden.

Dam No. 10, at present the upper one of the Muskingum system, extends the slackwater navigation for a distance of about 8¼ miles above Zanesville; ignoring the surface slope of Pool No. 10 at low water, the 9.95 feet of fall from Dresden to Zanesville then occurs in a distance of about 6¾ miles.

This portion of the Muskingum River was the part first provided with slackwater navigation, by the State of Ohio building a lock and dam, now in ruins, at the mouth of Symmes Creek, 10.7 miles above Zanesville. The Symmes Creek Lock was inaccessible during the low-water season, owing to its being located some distance above the point reached by the back water of Dam No. 10; for this reason and on account of small size of lock chamber, the river between Zanesville and Dresden was navigated by the smaller steamboats and by canal boats from the Ohio Canal only.. The dam at Symmes Creek was destroyed prior to the year 1877, as the following extract from annual report for that year of the State board of public works, relating to the Muskingum River, shows:

"That portion between Zanesville and Dresden seems to have been abandoned practically for boating purposes for a number of years. No boats now ply between these two points. The channel of the river is, however, in good condition, except at Symmes Creek, where there are shoals and ripples."

At Dresden the Muskingum River is connected with the Ohio Canal by a side cut 2½ miles in length. This canal runs from Portsmouth on the Ohio River to Cleveland on Lake Erie. The pool of the side cut is at an elevation of 25.6 feet above present low water in the Muskingum, which descent is overcome by three locks.

The river in the distance surveyed is crossed by four bridges—two highway bridges at Zanesville, the railway bridge 8 miles above Zanesville, and a highway bridge at Dresden.

The bridges at Zanesville are of recent construction and were built in accordance with the law regulating the construction of continuous bridges across the Muskingum River; they have each a channel span of 250 feet width and a clear height of 40 feet above navigable high-water line. The railway bridge, 8 miles above Zanesville, is a deck bridge with 127 feet space between piers; originally the channel span of this bridge was a through span, the lowest chord of which was of sufficient height for navigation at that time. In 1879 the span was rebuilt at its present height. Any improvements in the river would necessitate a change in the bridge, as the channel span, even if raised to its former height, would be an obstruction at ordinary high stages of the river.

The highway suspension bridge at Dresden is above the junction of canal with river and boat landing, and is therefore not here considered.

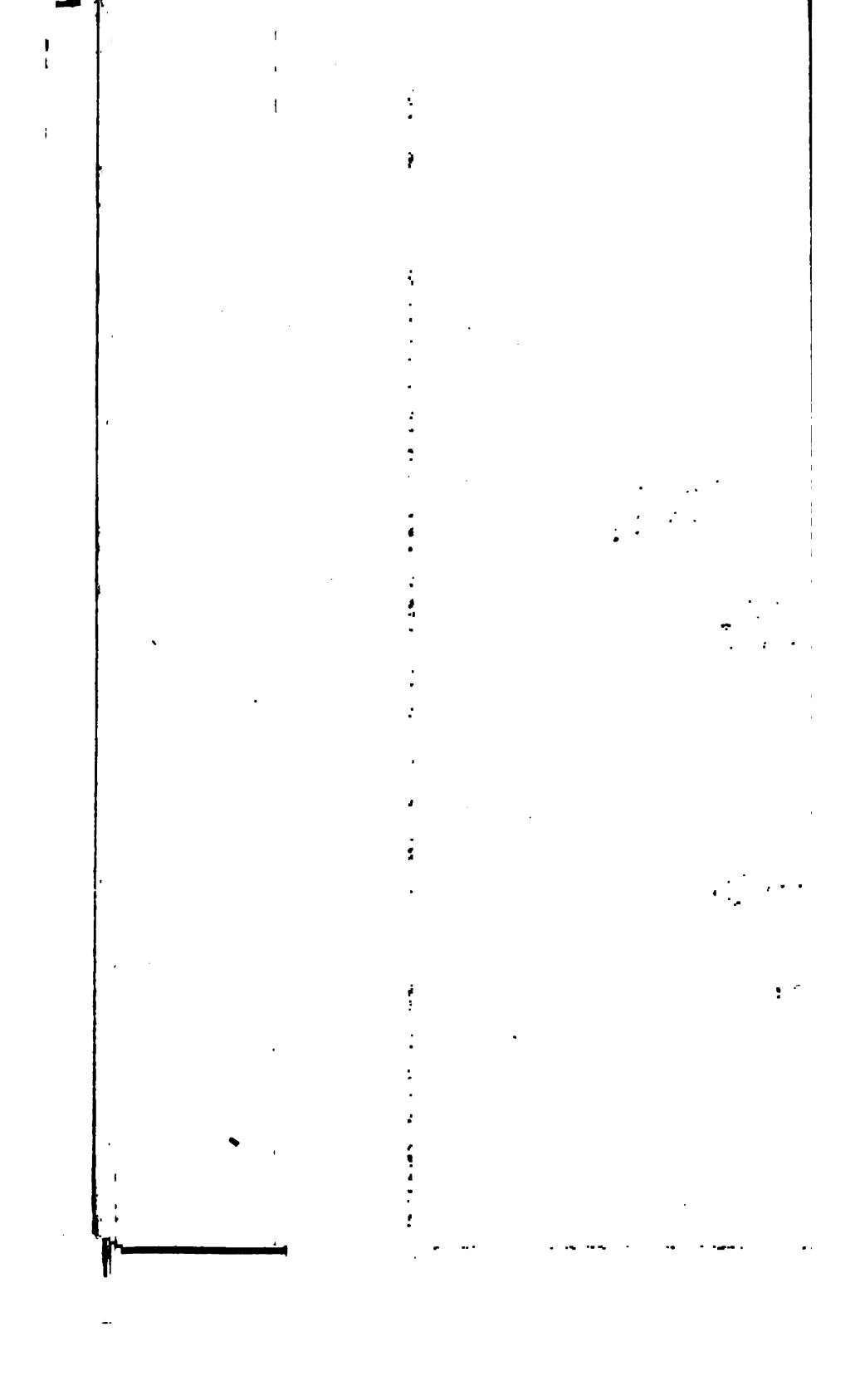
The river in this stretch is not affected by any important tributaries, Symmes Creek being but a few miles in length.

From the data gained by the survey it was established that to obtain navigable depth to Dresden, without excessive dredging, the dam should be placed near the Cincinnati and Muskingum Valley Railway Bridge. If Dam No. 11 were built at a point about 1,100 feet upstream from the bridge, and with a low-water lift of 11 feet, a navigable depth of not less than 6 feet would be assured to Dresden, with a depth of about 7 feet on the lowest miter sill of the Ohio Canal locks.

The elevations corresponding to these points would be as follows:

Elevation—	Feet.
Crest of Dam No. 10	688.62
Pool No. 10 at head	689.00
Crest of Dam No. 11	700.00
Pool No. 11 at Dresden	700.50
Lowest miter sill of canal lock	693.65

The effect of this lift upon the high stages of the river would probably cause some damage to the low bottom lands below Symmes Creek, but this could only be avoided by moving the dam up to or just below the old site at Symmes Creek and raising



the normal level of Pool No. 10 from 2 to 3 feet; as it would not be safe to raise Dam No. 10 above its present elevation on account of the flood waters at Zanesville, the raising of Pool No. 10 would have to be accomplished through a movable crest on the dam.

The following is an estimate of the cost of constructing a lock and dam at the site, 1,100 feet above the railway bridge.

The estimate is based on rock foundation for the abutment and about one-third of the dam; the remainder of dam and lock to be founded on piling. The height of top of lock is placed at 11½ feet above pool level, that being the height estimated as necessary to insure submergence at a stage when the other locks shall pass out of use:

Lock	$66,000
Abutment	3,000
Dam, 430 feet long	24,000
Guiding cribs and embankments	2,400
Land and lock-keeper's house	2,200
Total	97,600

Information relating to the commerce and navigation of the river between Zanesville and Dresden is not procurable for the years immediately preceding the abandonment of its navigation, as the improvement was leased to a company whose books are not accessible; but the local carrying done during the four years preceding the time when the lessees took the river, and upon which a toll was levied by the collector at Dresden, amounted to about 6,000 tons per year. As the toll on all through shipments was paid at Zanesville and was not reported by the Dresden collector, the above amount represents but a part of the actual commerce passing over this part of the river.

The restoration of the Ohio Canal in connection with the Muskingum River would give a water line from the Ohio River to Lake Erie.

Very respectfully, your obedient servant,

EDMUND MOESER, *Assistant Engineer.*

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.

APPENDIX D D.

IMPROVEMENT OF CHEAT, MONONGAHELA, AND ALLEGHENY RIVERS, WEST VIRGINIA AND PENNSYLVANIA.

REPORT OF MAJ. R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monongahela River, West Virginia, and Pennsylvania.
2. Operating and care of Locks and Dams Nos. 8 and 9, Monongahela River.
3. Purchase of Lock and Dam No. 7, Monongahela River.
4. Purchase of Lock and Dam No. 6, Monongahela River.
5. Cheat River, West Virginia.
6. Allegheny River, Pennsylvania.
7. Dam at Herr Island, Allegheny River, near Pittsburg, Pa.

EXAMINATION.

8. Tionesta River (Creek), Pennsylvania.

HARBOR LINES.

1. Pittsburg Harbor, Pennsylvania, and on both sides of the Ohio River as far down as Davis Island Dam.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., July 10, 1895.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1895.

Very respectfully,

R. L. HOXIE,
Major of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

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The Pittsburg and Homestead Bridge was completed. An inspection of t structure was made, and it was found to have been built in conformity with t plans approved by the Secretary of War. Bridges are also in course of constructi at Brady street, Pittsburg, at Glenwood, and at Bellevernon, Pa. Beyond nec sitating the exercise of the usual care required in passing structures of their cla these bridges will not interfere with safe and free navigation.

It may not be deemed improper at this time to call attention to a consideration the necessities of that portion of the Monongahela River lying between its mou and Dam No. 1 of the Monongahela Navigation Company. This part of the ri lies within the influence of the Davis Island pool. Standing alone, the great value of the Davis Island dam lies in its enabling loaded coal craft to be broug out of the Monongahela pools at seasons of moderately low water in the natu rivers, and harbored and made up into fleets below, ready for shipment upon t approach of a boating stage in the Ohio, thereby saving from one to three da valuable time. When the water becomes low the Davis Island pool will not at i normal level give a sufficient depth on what is known as "Pipetown Bar," abo three-fourths of a mile below Dam No. 1, to enable heavily-loaded coal vessels t float over it, and it is an annual occurrence to hear calls for relief at this pou Were the means at hand a much-needed good could be rendered by a little dredgi

Money statement.

July 1, 1894, balance unexpended	$21,464.0
Amount appropriated by act of August 17, 1894	20,000.0
	41,464.0
June 30, 1895, amount expended during fiscal year	463.0
July 1, 1895, balance unexpended	41,000.0
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	264,000.0

COMMERCIAL STATISTICS.

Commerce that passed through United States Locks Nos. 8 and 9 during 1894.

Month.	Lock No. 8.				Lock No. 9.			
	Ascending.		Descending.		Ascending.		Descending.	
	Passengers.	Freight.	Passengers.	Freight.	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*		*Tons.*		*Tons.*
January	339	382.75	425	499.75	363	525.50	368	166.0
February	267	859.81	339	43.25	364	337.75	290	53.0
March	324	635.20	375	1,654.75	367	330.75	336	1,008.0
April	327	291.61	279	3,031.19	265	385.50	164	2,186.5
May	420	394.80	352	1,180.65	264	673.00	185	2,148.5
June	528	396.47	446	3,860.37	477	481.25	405	1,542.0
July	1,330	464.10	1,169	890.08	1,392	658.25	1,201	558.5
August	2,133	737.18	2,095	1,704.85	1,985	653.45	1,877	165.5
September	1,792	366.85	1,944	561.72	1,495	574.00	1,508	67.0
October	893	588.60	921	1,608.71	956	662.05	867	529.0
November	697	935.20	716	2,061.89	730	1,534.00	722	877.0
December	253	338.10	240	840.67	226	534.75	161	475.5
Total	9,309	6,390.67	9,301	17,937.88	8,884	7,350.25	8,084	9,783.0

These tables show that the commerce during 1894 on the 14 miles of the Monongahela River which is controlled by the United States was as follows:

	Freight.	Passengers.
	Tons.	
Lock No. 8	24,328.55	18,61
Lock No. 9	17,134.10	16,96

The following table, compiled from the annual reports of the Monongahela Navigation Company, shows the commercial movement on the lower part of this river for the past eight years:

Articles.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
rick	5,27	4,504	6,333	7,856	7,897	8,181	6,344	1,874
attle and horses	501	565	729	648	783	647	611	456
lassified freight	16,486	17,450	18,334	23,169	21,746	21,891	20,076	27,387
oal and coke	2,998,690	4,400,996	3,084,175	4,486,322	4,291,874	3,884,162	3,865,592	4,655,408
ire clay	2,383	3,476	5,982	5,021	6,193	4,720	220	70
logs	259	379	266	340	302	107	81	122
ron:								
Ore	17,683	8,079	3,371	2,335				
In pigs	7	10	15	5	3			
umber	11,144	13,778	10,095	11,615	25,887	23,738	22,331	24,363
il	55							
ipe	2,285			2,394				
osts	258	489	700	1,089	4,910		2,256	1,140
osts, pit	30,472	22,432	18,707	29,336	9,786	14,952	4,194	4,875
ailroad ties	30	555	3,165	232	160			
and	89,230	63,085	73,590	105,600	74,600	89,900	113,400	94,950
heep	233	193	164	60	112	123	207	231
taves		7	26	140	109	98	178	246
teel rails	57,490	10,688	32,177	34,609	11,422	29,391	19,866	39,342
tone	910	3,636	9,580	811	4,595	2,120	5,647	2,685
imber	53,561	84,191	54,696	43,970	67,164	81,759	80,000	62,627
Whisky	49	88	134	180	922	1,515	1,641	2,313
Wood		184		58				
Total	3,287,005	4,634,785	3,322,239	4,755,790	4,528,465	4,163,304	4,142,644	4,918,089
assengers	50,584	44,714	45,811	31,828	48,744	80,590	98,440	81,550

Bridges completed over Monongahela River and its branches.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
int	0.0	Highway	1	780	73.3	Davis Island Dam.
ifthfield street	.8	do	2	344	55	Do.
ttsburg, Cincinnati, Chicago and St. Louis Rwy.	1	Railway	5	247	53	Do.
nth street	1.3	Highway	3	195	54	Do.
onongahela Connecting Rwy	2.8	Railway	6	300	51.8	No. 1, Monongahela River.
ltimore and Ohio (Glenwood)	6	do	8	184	57	Do.
omestead, Ann street	7	Highway	5	350	52	Do.
ttsburg, McKeesport and Youghogheny (Homestead.)	8	Railway	6	250	54	Do.
nnsylvania R. R. (Port Perry)	11.8	do	9	253	57	Do.
McKeesport and Duquesne	14.5	Highway	4	305	57	No. 2, Monongahela River.
Keesport and Bessemer	14.6	Railway	5	325	51.5	Do.
tsburg, McKeesport and Youghogheny (McKeesport).	15.5	do	6	221	40	Youghiogheny River.
Keesport Suspension	15.5	Highway	3	305	43	Do.
t View	16	do	3	258	40	Do.
avosburg	16.2	do	4	350	51.8	No. 2, Monongahela River.
iton	18	do	3	337	45.03	Youghiogheny River
zabeth	23	do	3	350	51	No. 2, Monongahela River.
nongahela City	32.5	do	4	216	42	No. 3, Monongahela River.
o and Baltimore Short Line R. R. (Greenfield).	52	Railway	4	238	52	No. 4, no superstructure.
nnsylvania R. R. (Redstone)	56	do	4	262	40	No. 4, Monongahela River.
wnsville	57.3	Highway	3	218	41.5	Do.
te Line R. R. (Point Marion)	90.5	Railway	5	109	33.5	Cheat River.
rgantown	102	Highway	1	606	45.7	No. 9, Monongahela River.
ltimore and Ohio R. R. (near Fairmount, W. Va.)	125.5	Railway				Above slack water.
rmount Suspension	126.5	Highway	4	190	39	Do.
ltimore and Ohio R. R. (near Fairmount, W. Va.)	127	Railway				Do.

Bridges authorized and not completed.

Name.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
South Tenth street, Pittsburg	1.3	Highway	3	500	53	Davis Island
South Twenty-second street, Pittsburg.	2	do	3	500	53	No. 1, Monongahela River
Pittsburg (Glenwood)	5.8	do	3	500	53	Do.
Homestead (Dickson street)	7.5	R. W. & H. W.	3	500	53	Do.
Youghiogheny Central Rwy. Co., near Dawson.	51	Railway	3	95	20	Youghiogheny River.

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
South Tenth street, Pittsburg		Oct. 22, 1894*		
South Twenty-second street, Pittsburg.	May 7, 1894	Aug. 21, 1894†	1 year from date of act.	3 years thereafter.
Pittsburg (Glenwood)	Apr. 2, 1894	Nov. 3, 1894†	do	Do.
Homestead (Dickson street)	June 7, 1894	Sept. 20, 1894	do	Do.
Youghiogheny Central Rwy. Co., near Dawson.		Sept. 24, 1892‡	2 years from date of charter.	5 years thereafter.

* For rebuilding bridge.
† Permit for this bridge replaces permit for bridge on same site having dimensions given in last annual report.
‡ Company chartered by State of Pennsylvania.

DD 2.

OPERATING AND CARE OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER.

The Monongahela River from Pittsburg to Morgantown, W. Va., is canalized by nine locks and dams, of which the first seven are the property of the Monongahela Navigation Company, and the eighth and ninth are the property of the United States. The eighth dam is 88.1 miles above Pittsburg, and Morgantown, the head of the slack water, is 102.16 miles from the same. It may, therefore, be stated that 14 miles of this river is under the direct control of the United States and 88 miles is under a private corporation.

The following is a statement of date and amount of all allotments for this work:

August 15, 1884	$1,000.00	July 17, 1889	1,480.00
September 1, 1884	4,000.00	October 7, 1889	1,500.00
November 3, 1884	4,500.00	November 6, 1889	1,200.00
December 20, 1884	500.00	July 24, 1890	12,300.00
June 1, 1885	100.00	July 8, 1891	24,260.00
July 22, 1885	1,000.00	July 21, 1892	34,017.50
July 10, 1886	1,200.00	July 21, 1893	23,574.70
March 1, 1887	1,100.00	July 23, 1894	25,664.00
July 1, 1887	11,000.00		
July 11, 1888	6,270.00	Total	157,656.50
October 27, 1888	3,000.00		

During the past fiscal year these locks have been successfully operated without interruption to navigation except from December 2

1894, to January 17, 1895, and from January 28 to March 6, 1895, during which periods the Monongahela River was closed by ice, compelling the suspension of navigation; also on March 17, navigation was again interrupted by a freshet, which overflowed both locks.

From pools 8 and 9 obstructions have been removed aggregating 2,437 tons of snags, logs, trees, etc.

At lock No. 8 repairs were made to the bank protection and operating machinery, and lumber procured for repairing fences. The apron of the dam sustained some injury from the ice and high water of the past winter, and will need repairs. The repair of this dam was contemplated at the date of the last annual report, but a careful inspection made at extreme low water, when the crest of the dam was accessible, indicated no change since 1891, and it was decided not to disturb the dam merely for the purpose of lowering the crest. No change is apparent at this date, but a critical examination will be made during the present season to determine whether any work should be done upon it.

At Lock No. 9 the Stoney valve was repaired, as well as the stone arch over the opening for the valve. Lumber for rebuilding outbuildings was procured; new lock gates were constructed. Repairs were made on the dry wall below the abutment on west side of river. The dam is in good condition.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

[Extract from report of Mr. Golay.]

During the winter of 1894–95, the Monongahela River was twice closed by ice, and in consequence thereof navigation was suspended from December 29 to January 17, and from January 28 to March 6. On March 17, navigation was again interrupted by a freshet, which overflowed both locks. During the remainder of the year these locks were successfully operated without interruption to navigation.

In July, the launch *Albatross* was repainted. From January 6 to March 25, she was laid up in winter quarters at Stoker's Ice Harbor. During the fiscal year she ran 1,306.4 miles, rendering efficient service, visiting the locks and transporting tools and light supplies.

The floating shelter for launch was repaired by building two pontoons and placing them under the shelter for floats, instead of the raft of poplar logs, as at first constructed. The poplar logs had become saturated and lost much of their buoyancy.

The removal of obstructions to navigation in Pools 8 and 9 was commenced on October 1 and continued to October 27. The steamboat *Two Brothers*, with crew including six deck hands, hired from Hulings Brothers, Pittsburg, Pa., and two of the Government flats rigged up with an A-frame on them, were employed on this work. Two thousand four hundred and thirty-seven tons of snags, logs, trees, etc., were removed, leaving the channel clear. The removed obstructions were suitably disposed of by cutting them into small pieces and dropping them just above the dams and in the deep water back of Grandville Island, the lighter portions floating away.

LOCK AND DAM NO. 8, MOUTH OF DUNKARD CREEK.

Some minor repairs were made on the bank protection below the lock.

New sheaves for the closing chains of the lower gates were procured and put into place, as the flanges of the old sheaves were found to be broken.

In 1894 a new worm wheel was procured and placed for operating the gate and valve at lower end of land wall. During the past fiscal year three other new worm wheels were procured, and the one for upper end of land wall was put into place. The other two have not yet been placed, as the old worm wheels on the river wall were not so much worn as those on the land wall.

Lumber for repairing fences has been ordered and delivered to the lock, and the repairs will soon be made.

The ice and high water of the winter and spring months caused additional caving of the banks in the vicinity of the lock on both sides of the river. The caving on the east side of the river extends from the lower end of the Government ground down about 300 feet, and has an average width of about 12 feet. About the same amount of caving occurred on the west side of the river just below the mouth of

Dunkard Creek. The south bank of Dunkard Creek, immediately above the end of the retaining wall below the abutment, has also caved, and the river bank above the abutment is scouring somewhat. Also a few yards of the paving below the abutment was washed out and displaced.

The freshet of January 7 partly filled the turbine races with mud, and piled about 15 tons of mud, leaves, drift, brush, and trunks of trees against the upper gates. A force of men was employed, who removed this deposit from against the upper gates, and the lock was put in order before it was needed for navigation.

After the winter freshets it was discovered that for a distance of about 250 feet the sheeting of the apron of the dam had raised, together with the purlins and a few of the timbers beneath, the face of the dam having parted about 3 feet below the sheeting. The injury is thought to be due to the heavy ice and high water of the past winter, of which the freshet in January was the most impetuous, carrying over the dam a gorge of heavy ice and thousands of logs from the breaking of the Dewing & Sons' timber boom in the mouth of Cheat River. Repairs should be made during the coming low-water season.

LOCK AND DAM NO. 9, HOARDS ROCKS.

The discharge (Stoney) valve was repaired by placing new channel bars for the travelers to run in. The old channel bars had split from bottom upward; had spread open so that the ends caught on the bolts that hold the guides to the wall and thus prevented closing the valve. In March it was discovered that the lower part of the stone arch over the opening for the discharge valve had crumbled away, leaving an opening between the top of the valve and lower part of the arch. As a temporary repair this opening was closed by securing plank vertically to the wall above, allowing the ends to extend down just below the top of the valve.

Lumber for rebuilding outbuildings had been procured and is on hand at the lock. This work will be commenced soon.

New lock gates were constructed, but because of delay in the delivery of hollow-quoin timber, preparations for hanging the new gates could not be completed till late in the fall. On account of the uncertainty of favorable conditions of the weather and river at this season of the year, the work of renewing the hollow quoins and changing the gates was postponed till the following low-water season.

The ice break-up and high water of January 7 loosened the two top courses of the timbers of the guide crib at the head of the river wall, carrying away about half of the loosened timbers and some of the stone filling; also a basin-shaped hole, 20 by 30 feet, was washed out just below the lower wing wall to a depth of 12 feet below the top of the wing wall, undermining some of the riprapping of the bank and several of the stone steps leading from the top of the bank down to the lower wing wall. Some of the riprap stone thus washed out was carried over the guide wall and deposited in the approach of the lock a short distance below the lower gates, somewhat obstructing the entrance to the lock. This deposit of riprap stone, amounting to 57 cubic yards, has been removed and placed back of the guide wall and the stone steps have been lifted from the pit. It is the intention to repair the guide crib above the river wall and fill the washout just below the lower wing wall during the coming working season.

The dam is in good condition. Recent careful examination shows the concrete top, put on in 1893, to have stood very well.

Some minor repairs were made on the dry wall below the abutment on the west side of the river.

An appropriation of $20,000 for improving Monongahela River below Morgantown could be advantageously used for lengthening the guiding cribs above Locks 8 and 9, constructing a dike below Lock No. 9 to destroy a troublesome eddy, raising terreplein at Lock No. 9, and constructing a telephone line to connect Locks 8 and 9 and the Morgantown office.

Money statement.

July 1, 1894, balance unexpended	$6,182.56
Amount allotted for fiscal year ending June 30, 1895	25,664.00
	31,846.56
June 30, 1895, amount expended during fiscal year	16,636.71
July 1, 1895, balance unexpended	15,209.85
July 1, 1895, outstanding liabilities	1,282.25
July 1, 1895, balance available	13,927.60
Amount (estimated) for expenditure in fiscal year ending June 30, 1896	*20,372.40
Amount available for fiscal year ending June 30, 1896	34,300.00

*Amount allotted if estimate is approved.

Detailed statement of expenses incurred in operating and care of locks and dams on the Monongahela River during the fiscal year ending June 30, 1895.

Month.	Operating expenses.				Repairs.				Tools and appliances.	Grand total.
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Hire of boats and barges.	Labor.	Material.	Total.		
1894.										
July	$560.00	$5.12	$12.00	$577.12	.....	$26.21	$936.96	$963.17	.....	$1,540.29
August	555.00	48.70	20.00	623.70	.....	831.14	176.82	1,007.96	$2.55	1,634.21
September	701.67	98.00	12.00	811.67	.....	970.98	1,264.62	2,235.60	.....	3,047.27
October	550.00	66.13	13.50	629.63	$804.00	887.82	131.76	1,823.58	.06	2,453.27
November	550.00	1.62	13.50	565.12	.....	575.83	89.32	665.15	.99	1,231.26
December	691.67	.....	32.50	724.17	.....	568.09	55.13	623.22	18.06	1,365.45
1895.										
January	500.00	35.86	23.90	559.76	.....	283.73	7.73	291.46	.....	851.22
February	661.67	.....	23.90	685.57	.....	6.75	3.13	9.88	.....	695.45
March	553.33	.....	23.95	577.28	5.00	7.85	3.13	15.98	.....	593.26
April	990.00	1.55	23.21	1,014.76	.....	1.65	.....	1.65	.....	1,016.41
May	550.00	.....	18.70	568.70	.....	101.75	160.41	262.16	.....	830.86
June	1,135.00	31.35	107.16	1,273.51	.....	.....	201.60	201.60	514.35	1,989.46
Total	7,998.34	288.33	324.32	8,610.99	809.00	4,261.80	3,030.61	8,101.41	536.01	17,248.41

Commercial statistics are attached to the report for the improvement of Monongahela River.

D D 3.

PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER.

The case of the United States *v.* The Monongahela Navigation Company, for the condemnation of this structure, was heard in the circuit court of the United States for the western district of Pennsylvania in November, 1890, and the value of the work was fixed at $209,000, exclusive of the value of the franchise. The Navigation Company took an appeal to the Supreme Court of the United States, where the case was argued at the October term, 1892. The judgment of the circuit court was reversed and case remanded, with instructions to grant a new trial.

[*Decision.*—October term, 1892.—Statement of the case.—Monongahela Navigation Company *v.* United States.—Appeal from and error to the circuit court of the United States for the western district of Pennsylvania.—No. 722.—Argued October 25, 26, 1892.—Decided March 27, 1893.]

In the proceedings taken under the act of August 11, 1888 (25 Stat., pp. 400, 411, c. 860), to condemn Lock and Dam No. 7 of the Monongahela Navigation Company, that company is entitled, under the provisions of the fifth amendment of the Constitution, to recover compensation from the United States for the taking of the franchise to exact tolls, as well as for the value of the tangible property taken.

The assertion by Congress of its purpose to take the property which that company had constructed in the Monongahela River by authority of the State of Pennsylvania, did not destroy the franchise granted to the company by the State. * * *

The judgment, therefore, will be reversed, and the case remanded with instructions to grant a new trial.

The act of August 11, 1888, excludes the consideration of the franchise and no further proceeding could be had under that act. The river and harbor act of August 17, 1894, and the joint resolution of March 2, 1895, provide for ascertaining "the sum of money necessary to acquire by purchase the locks and dams on the Monongahela River, in Pennsylvania, belonging to the Monongahela Navigation Company, as a whole and separately, and also to take testimony as to the value of the said improvements and the commercial importance of free navigation of said river, * * * to the end that Congress may determine as to

the expediency of making the navigation of said river free from tolls." The Monongahela Navigation Company having declined to sell their property (see Ex. Doc. No. 249, Fifty-third Congress, third session), it can not be purchased. The testimony required to be submitted to Congress has been requested from all parties interested, and must, under the terms of the joint resolution of March 2, 1895, be taken before September 30, 1895.

Money statement.

July 1, 1894, balance unexpended	$161,831.77
July 1, 1895, balance unexpended	161,831.77

D D 4.

PURCHASE OF LOCK AND DAM NO. 6, MONONGAHELA RIVER.

An appropriation of $162,000 was made by river and harbor act of September 19, 1890, for acquisition of this structure from the Monongahela Navigation Company, and one of $5,000 for cost of condemnation after title to Lock and Dam No. 7 shall have been acquired by the United States. As the latter has not yet been obtained, no steps have been taken toward negotiating for Lock and Dam No. 6.

Money statement.

July 1, 1894, balance unexpended	$167,000.00
July 1, 1895, balance unexpended	167,000.00

D D 5.

IMPROVEMENT OF CHEAT RIVER, WEST VIRGINIA.

The river and harbor act of September 19, 1890, contained an appropriation of $13,000 for the improvement of Cheat River. This is the only appropriation ever made for this river.

The object of the improvement was to make the river navigable for loose logs, so as to bring out the immense supplies of timber found on the Cheat River and its tributaries. In its natural condition it was impossible to bring down rafts, and a large percentage of the loose logs was stranded among the rocks.

The rough part of the river commences about 3 miles below Rowlesburg and terminates at Beaver Hole, 16 miles above the mouth, where the river emerges from Laurel Ridge. The total length of difficult river is 30 miles. The original project for the improvement of the river was the removal of such rock obstructions as interfered with the free passage of logs on a 6 or 8 foot stage of water. At the suggestion of lumbermen and others interested in the improvement of this river, an additional project was adopted of making a low-water channel from near Rowlesburg down the river, in which logs could be floated on a rise of from 2 to 3 feet. The improvement was completed so far as the funds available permitted in 1892, since which time no work has been done. The channel has been greatly improved, and is now in fair condition between Rowlesburg and Green Island, a distance of 20¼ miles.

An additional sum could be advantageously expended in removing more rock from the channel. Between Pringle Run and Green Island 3,000 cubic yards of rock, mostly in the low-water channel, and between Green Island and Forge Island 7,000 cubic yards of rock could be thus

emoved. Guide cribs should also be constructed at the heads of some ow bars to keep logs in the channel.

For the excavation of rock and construction of cribs the sum of $20,000 could be expended to advantage.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

[Extract from report of Mr. Philip Golay.]

No work was done on Cheat River, West Virginia, by the United States during the fiscal year ending June 30, 1895, as the appropriation for improving this river was exhausted in January, 1892.

Since the suspension of operations by the United States in 1892, Dewing & Sons, who are engaged in the lumber business and have mills at Point Marion, Pa., have expended $3,200 in additional improvements between Green Island and the mouth of the river. During and prior to operations by the Government the same firm expended $2,800 at various places between Rowlesburg and the mouth, making a total of $6,000 expended by them in improving this river. Their work consisted in blasting and leveling down rock obstructions, and in removing from the banks between high-water lines overhanging trees, brush, etc., that were an obstruction to rafting. The firm has aided materially in the improvement of the river, as they are experienced in handling timber in the stream and well understand where improvements are most needed.

The sum of $20,000 could yet be advantageously expended, blasting and leveling down rock obstructions and constructing guide cribs at the heads of low bars to keep logs in the channel.

Money statement.

July 1, 1894, balance unexpended	$6.36
June 30, 1895, amount expended during fiscal year	3.20
July 1, 1895, balance unexpended	3.16
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	20,000.00

Timber product of Cheat River for year ending December 31, 1894.

Month.	Received by mills at mouth of river.	Passed on to points below.	Total.
	Feet, B. M.	*Feet, B. M.*	*Feet, B. M.*
February	990,996	49,548	1,040,544
April	1,153,002	57,648	1,210,650
May	2,123,568	106,176	2,229,744
November	22,002	1,098	23,100
December	723,768	36,186	759,954
Total	5,013,336	250,656	5,263,992

Timber product of Cheat River for twenty years ending December 31, 1894.

Year.	Received by mills at mouth of river.	Passed on to points below.	Total.	Year.	Received by mills at mouth of river.	Passed on to points below.	Total.
	Feet, B. M.	*Feet, B. M.*	*Feet, B. M.*		*Feet, B. M.*	*Feet, B. M.*	*Feet, B. M.*
1875	204,498	68,166	272,664	1885	3,324,498	1,108,164	4,432,662
1876	112,302	37,836	150,138	1886	2,716,500	905,502	3,622,002
1877	104,298	34,770	139,068	1887	3,621,498	1,207,164	4,828,662
1878	112,002	37,332	149,334	1888	2,167,500	722,502	2,890,002
1879	139,998	46,668	186,666	1889	3,375,000	1,125,000	4,500,000
1880	255,000	85,002	340,002	1890	2,244,702	748,236	2,992,938
1881	229,998	76,668	306,666	1891	7,986,000	399,306	8,385,306
1882	256,998	85,668	342,666	1892	7,835,730	391,788	8,227,518
1883	550,002	183,336	733,338	1893	3,899,262	116,964	4,016,226
1884	324,498	108,168	432,666	1894	5,013,336	250,656	5,263,992

D D 6.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this river:

March 3, 1879	$10,000
June 14, 1880	20,000
March 3, 1881	25,000
August 2, 1882	15,000
July 5, 1884	35,000
August 5, 1886	30,000
August 11, 1888	25,000
September 19, 1890	20,000
July 13, 1892	25,000
August 17, 1894	12,500
Total	217,500

The original condition of the Allegheny River as to depth, width, and navigability can not be definitely stated from existing records, both the low water and the elevation of the river bed being variable. The approved project for the improvement of the river is the removal of obstructions from the channel and the construction of low dams to close double channels, and of dikes to confine the waterway where the river is too wide. Much benefit to navigation has resulted.

During the past fiscal year Dike No. 1, at Cowanshannock, was completed, and repairs made to dam and abutment at Tionesta of injuries caused by heavy scour at that place. Obstructions were removed from the channel aggregating 6,645 tons of rock and 72 snags. The dikes proposed at Cowanshannock being somewhat novel in design, it was thought best during the past working season to construct only one of these and subject it to a practical test of the winter ice. It has not yet been possible to make a critical examination of this dike, but it is believed that it has sustained no serious injury, and the other dike of a similar type planned for the same locality will be put in as soon as a good working stage of the river permits.

This work has been under the immediate supervision of Mr. J. W. Arras, assistant engineer.

[Extract from report of Mr. J. W. Arras.]

At the beginning of the year the only work of improvement under way was that at Cowanshannock, 48 miles above Pittsburg, on which operations were suspended at the close of the working season of 1893. Other work under contemplation was the removal of obstructions from the navigable channel below Tionesta.

New works.—When work was suspended at Cowanshannock the riprap stone dam between the bar and right bank had been completed, and the timberwork of Dike No. 1, opposite the ripple at the mouth of Cowanshannock Creek, about finished in accordance with the plan approved and a portion of the stone filling put in place. The piles and timber for Dike No. 2, located 2,000 feet below Dike No. 1, had also been procured, and were stored on the bank at its location. The unfinished work sustained practically no injury during the period of suspension. On July 13 this work was resumed under the immediate supervision of Mr. I. V. Hoag, jr., assistant engineer. To add to the stability of the dike the timber work, which originally began at a distance of about 230 feet from the bank, was extended back to the bank. The interior was then filled with rubble stone to the required elevation and the surface paved to the depth of 1.5 feet with hammer-dressed stone. No rises occurred to interrupt the progress of the work until September 23, when the dike was practically finished. At that time the water rose to the height of 11 feet above low water. After the rise it was discovered that considerable scour had taken place around the dikehead at the outer end, the depth in some places being from 8 to 10 feet. This scour caused a slight undermining of a part of the dikehead, endangering some of the

paving, and in order to permit of its proper repair, as well as to prevent a future recurrence of the scour, brush mattresses were constructed and sunk to the bottom with heavy riprap stone. The entire work was completed early in the month of October. The length of the dike, exclusive of the dikehead 50 feet long across the outer end, is 525 feet, its width at base 24 feet, and height for a distance of 260 feet from the outer end 4 feet above low water. From a point 260 feet from the outer end the structure rises 3 inches per 100 feet to the bank.

Dike No. 2 was not built, and the material remaining for its construction was permitted to remain stored on the bank.

This series of works was designed to improve the low-water channel by causing deposits along the right shore and concentrating the flow of water within a limited space on the shoals. Sufficient time has hardly elapsed to judge of its ultimate effect on the river bed, nevertheless favorable reports have been received from navigators as to the benefits already derived.

Repairs to existing works.—Heavy scour caused a slight undermining of the dam at Tionesta, and of the abutment at the left bank. The necessary repairs were made with the expenditure of 20 cubic yards of heavy stone and 40 cubic yards of gravel.

Removal of obstructions.—On October 1 two parties, equipped with the necessary tools and appliances, began the removal of rock and other obstructions from the channel of the river between Tionesta and Pittsburg. Owing to high water and the lateness of the season only a small amount of work was accomplished when a suspension of operations was necessary. Mr. Hoag reports 6,645 tons of rock and 72 snags removed.

Condition of existing works on July 1, 1895.—Information has been received that the log chute on the Corydon Dam, the abutments of the dams at Pithole and Tionesta, and the dam at Nicholsons Island have suffered injury during the past winter, but to what extent is not definitely known, since no examinations have yet been made. As far as heard from all other works are in good condition.

Occupancy of or injury to public works.—No information has been received that any structures or works of any kind on the Allegheny River, belonging to the United States, have been used, occupied, or injured by anyone.

Bridges.—It is not known that any changes have been made in any of the bridges over the Allegheny River during the past year.

Structures and operations interfering with navigation.—The Corydon mill dam in which a gap 270 feet wide existed at the beginning of the year, which entirely blockaded navigation at that point, was repaired by the owners, relieving navigation.

A complaint was received that the sand diggers belonging to the Pittsburg Plate Glass Company were obstructing navigation in the vicinity of the company's factories at Ford City, 40 miles above Pittsburg, by depositing large quantities of gravel in the channel. A thorough investigation was made, and it was found that all gravel excavated by the diggers was placed in dump scows and deposited in deep water out of the way of navigation, and that navigation is not being obstructed.

Money statement.

July 1, 1894, balance unexpended	$14,212.48
Amount appropriated by act of August 17, 1894	12,500.00
	26,712.48
June 30, 1895, amount expended during fiscal year	7,133.06
July 1, 1895, balance unexpended	19,579.42
July 1, 1895, outstanding liabilities	17.12
July 1, 1895, balance available	19,562.30
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	25,000.00

COMMERCIAL STATISTICS.

The information collected by this office for the calendar year 1892 is submitted, with letter from the Chamber of Commerce of Pittsburg, which explains the difficulty of collecting accurate statistics. The exhibit is a fair annual average of present freight movement on the Allegheny River:

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Barges	4,860	Lath	575
Bark	3,215	Manure	8,325
Barrels	900	Nitroglycerin	1
Boat bottoms	28,656	Piles	4,113
Brace poles	688	Pit posts	5,437
Cattle and horses	286	Rough lumber	92,092
Check posts	1,205	Sand	64,099
Coal	195	Shingles	400
Fire clay	3,120	Staves	525
Gas pipe	450	Stone	18,579
General freight	1,928	Timber	104,013
Gravel	10,332		
Hay	300	Total	354,894

Passengers carried 4,627.

In addition to the above, the following statement of the principal commercial movements in the Allegheny Harbor at Pittsburg is given:

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Brick	400	Manure	16,780
Cars, loaded	415,449	Railroad ties	9,221
Cars, empty	98,424	Sand	103,261
Coal	246,632	Staves	690
Gas pipe	18,605	Vegetables	1,204
General freight	2,580		
Gravel	35,450	Total	953,406
Lumber	4,700		

Passengers carried, 27,000.

The timber and most of the lumber transported on the Allegheny River is rafted at headquarters and floated to its destination. The rafts vary in size from 50 feet by 400 feet above the Tionesta to 70 feet by 400 feet below it, and draw from 1.5 feet to 3 feet of water. The remaining portion of the lumber and nearly all other timber products, such as shingles, lath, poles, posts, bark, etc., are transported to down-river points in the boat bottoms which are manufactured in the Tionesta and Clarion valleys. About 800 of these bottoms are annually built and run out of the Allegheny. They are 26 feet by 176 feet and draw from 8 inches when empty to 16 to 20 inches when loaded. Their carrying capacity is 140 tons. There are also manufactured annually in the Tionesta Valley 90 coal barges, about one-half the number annually required by the Pittsburg coal trade. All minerals and materials other than timber products are generally transported in guypers and flats drawing from 1.5 to 4 feet and having a carrying capacity of from 75 to 200 tons. These guypers and flats are usually towed by small boats. The steamboat *Nellie Hudson No. 3*, running in the packet trade between Pittsburg and Kittanning, a distance of 45 miles, has a tonnage of 200.

CHAMBER OF COMMERCE OF PITTSBURG,
Pittsburg, Pa., July 12, 1894.

DEAR SIR: Your request for information relating to the commerce of the Allegheny River, directed to the Chamber of Commerce, was referred to me by the river and harbor committee, and speaking for that committee, I beg leave to reply as follows:

There are no officials charged with the duty of collecting the records of business done upon our rivers, and especially in the case of the Allegheny River it is difficult to obtain accurate reports of the extent and value of its commerce. The printed statements which you inclose, giving details of certain articles of commerce transported on this river, I am satisfied, after some inquiry, includes all of the leading commodities, but the quantity of some of them will vary greatly in different years; but upon the whole the statistics furnished by yourself, I believe, are reasonably correct in the sum totals for an average year.

The business of 953,000 tons for the Allegheny Harbor, which at present is only to be considered that portion made permanently navigable by back water from the

Davis Island Dam, in the Ohio, will no doubt be vastly increased in the near future following the completion of the Herr Island Dam, which will extend navigation to numerous industrial establishments situated above the influence of the Davis Island Dam.

The undeveloped resources of the Allegheny Valley, in the opinion of the Chamber of Commerce, amply warrant an extension of the slackwater a considerable distance up the river. Some of these resources of coal and building stone never can be properly developed without the extension to them of cheaper means of transportation.

In past years the Chamber of Commerce has urged upon Congress more liberal appropriations for the improvement of the navigation of this great river. Its showing of fully 1,000,000 tons of freight per annum in its natural unimproved condition should be enough to induce the faith that a liberal expenditure here would be fully warranted by the results to be secured. The improvement of this river should not be regarded as a local matter, for the products of the Allegheny Valley are shipped, to the value of millions of dollars annually, to the Western and Southern States.

Very respectfully, yours,

JOHN F. DRAVO,
Chairman River and Harbor Committee.

Capt. R. L. HOXIE,
U. S. Engineer.

Bridges over Allegheny River between Pittsburg, Pa., and Olean, N. Y.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	No. of spans.	Channel span between centers of piers.	Height above low water.	When built.
	Miles.			*Feet.*		*Feet.*	*Feet.*	
Union	0	Highway	Wooden trussed arch (Burr).	1,060	5	212	35.1	.....
Sixth street	.5	....do	Iron bowstring truss	1,036	2	445	33	*1893
North Side (Seventh st.)	.6	....do	Stiffened suspension iron bars.	1,080	4	330	34.8	1884
Ninth street	.7	....do	Sub-Pratt truss	1,044	5	209	34	*1892
Pittsburg, Fort Wayne and Chicago R. R.	.9	Railroad.	Iron lattice truss	1,167	9	152	35.3	.....
Sixteenth street	1.3	Highway	Wooden trussed arch (Burr).	840	4	210	33	.....
Thirtieth street	2.4	....do	Iron truss, continuous girder.	760	3	302	37.5	.....
Pittsburg Junction R. R. (Thirty-third street).	2.65	Railroad.	Open iron truss	841.4	4	{210.3 {250	{41	1884
Forty-third street	3.4	Highway	Wooden trussed arch (Burr).	980	4	244	37	.....
Sharpsburg (Butler st.)	5.3	....do	Open iron truss	905	5	181	38	.....
Freeport (West Pennsylvania R. R.).	29.6	Railroad.	.....do	795	5	185	47.3	*1887
Kittanning	44.9	Highway	Iron bowstring girder	900	5	180	32.7	.....
Brady's Bend	69.5	....do	Open iron truss	750	4	200	36.2	*1885
Parker	83.1	....do	Iron bowstring girder	790	4	197	34.5	*1885
Foxburg	86	Railroad and highway.	Wooden Howe truss, decked.	530.7	3	176.9	35.3	.....
Emlenton	89.6	Highway	Open iron truss	456	2	228	36.6	*1883
Big Rock	122	....do	Wooden truss	700	4	175	27	1879
Franklin	123.1	....do	Wood and iron truss	711	4	175	31.5	.....
Oil City	130.2	....do	Suspension wire cables	700	3	500	41	.....
Oil City (Relief)	130.3	....do	Iron truss	830	4	325	31.9	1893
Oil City	130.4	....do	Open iron truss	1,100	6	200	36.6	*1885
Allegheny Valley R. R.	130.6	Railroad.	Wooden trussed arch	450	3	150	29	*1883
Tionesta	150.6	Highway	Iron bowstring girder	435	4	120	25.5	.....
Hickory	157.3	Railroad and highway.	Wooden Howe truss	646	4	161.5	23.2	1883
Tidioute	165.3	Highway	Suspension wire cable	536	2	268	27.8	.....
Philadelphia and Erie R. R.	187.1	Railroad.	Covered wooden truss	450	3	150	18.6	.....
Warren	187.7	Highway	Suspension wire cable	452	1	452	24.4	.....
Western New York and Pennsylvania R. R.	188.1	Railroad.	Iron truss	526	3	175	18	*1889
Glade Run	189.9	Highway	Wooden Howe truss	568	4	142	20.2	1882
Great Bend (Western New York and Pennsylvania R. R.).	197.7	Railroad.	.....do	634	4	158.5	23.1	1882

* Rebuilt.

Bridges over Allegheny River between Pittsburg, Pa., and Olean, N. Y.—Continued.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	No. of spans.	Channel span between centers of piers.	Height above low water.	When built.
	Miles			*Feet.*		*Feet.*	*Feet.*	
Onoville	212.4	Highway	Suspension wire cable	505	7	82	13.1	1884
Quaker Bridge	218.2	....do	Wooden queen truss	300	4	75	17.5	.....
Red House	224	....do	Open iron truss	375	3	125	18.1	* 1881
West Salamanca	230	....do	Open iron truss, parabolic channel span.	643	4	154	17	.....
Western New York and Pennsylvania R. R.	231.1	Railroad.	Wooden Howe truss	394	3	146	19.6	1883
Salamanca	231.8	Highway	Iron parabolic truss	400	3	133½	15	1883
South Carrollton	237.8	Railroad and highway.	Wooden truss	280	6	84	17	* 1888
Tuna Creek	239.9	Highway	Open iron truss	274	2	137	17	1885
Erie Railroad (Bradford Branch).	240.3	Railroad	.....do	192	1	192	12.4	1883
Buffalo, Rochester and Pittsburg R. R.	240.3	....do	.....do	203	1	203	14.1	1882
Allegheny	250.6	Highway	Iron bowstring girder	400	4	100	19.4	.....
Western New York and Pennsylvania R. R.	251.3	Railroad.	Wooden Howe truss	329	2	164.5	17.4	1882
Do	253.7	....do	Wood and iron truss	303	2	171	19.5	1885
Olean	255	Highway	Iron truss	240	3	60	16.5	.....

* Rebuilt.

Bridges authorized and not completed.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	Number of spans.	Channel span between centers of piers.	Height above low water.
	Miles.			*Feet.*		*Feet.*	*Feet.*
Tarentum	20	Highway.	Iron truss	951	4	306	45
Creighton	20.4	.....do	.....do	1,100	4	308	45
Kensington	20.3	.....do	.....do	1,200	4	311	45

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Tarentum	.....	July 10, 1893	2 years from date of charter.*	5 years thereafter.
Creighton	Mar. 7, 1893	Feb. 27, 1894		
Kensington	.....	Apr. 28, 1894		

* Company chartered by State of Pennsylvania.

D D 7.

DAM AT HERR ISLAND, ALLEGHENY RIVER, NEAR PITTSBURG, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this work:

August 5, 1886	$37,500
August 11, 1888	35,000
September 19, 1890	35,000
July 13, 1892	40,000
August 17, 1894	40,000
Total	187,500

The object of this dam is to begin a system of slack-water navigation on the Allegheny River and enlarge the harbor room at Pittsburg to the extent of the pool formed by the dam.

The original project was for a fixed dam, but in compliance with the request of the authorities of Pittsburg and Allegheny City the Secretary of War has ordered that the dam at Herr Island be made a movable one. This change in design necessitated a corresponding change in the estimated cost of the work. The estimated cost of the work under the plans approved July 10 1894, is $600,000.

Delay was caused by suits brought by the riparian owners, but a change of location, so that a waterway for landings, 55 feet in width, is left between the inner wall of the lock and the river bank, satisfied the riparian owners and their opposition was withdrawn. The land necessary for the lock and dam has been acquired and all legal questions as to damages to adjoining property settled.

Prior to June 30, 1894, the cofferdam inclosing the site of the lock was completed and the greater part of the necessary plant for the construction of the lock and dam purchased and received at the work. The pumping out of the cofferdam would have been attempted but for defects in the pumping engine which developed under steam pressure. Temporary buildings were completed for shops, storehouses, and office. A well 122 feet deep was put down and equipped with a pump for furnishing drinking water to the men. Plans for the lock and dam were formulated in conformity with the conclusions of the Board appointed by Special Orders No. 20, headquarters Corps of Engineers, April 24, 1894, and estimates completed.

The treacherous character of the river bottom and the contraction of the waterway by encroachments upon either side have made it a matter of some difficulty to maintain a cofferdam at this point during high water. Extensive repairs had been required because of injury sustained by the cofferdam upon the occasion of two floods during the winter of 1893–94. It was desirable that work should be vigorously pushed for this reason.

During the past fiscal year, the plans for this work were approved July 10, 1894, and the pumping out of the cofferdam commenced July 7, 1894. The result is shown in the following extract from the project submitted under modified plan of August 27, 1894:

The modification of plan is necessitated by the failure of the cofferdam. In my last report of operations I have described in detail the first attempt to pump out the cofferdam, and under the head of probable operations for next month have indicated the steps that would be taken for an exhaustive trial. The second attempt to pump out was made with a plant consisting of three 12-inch centrifugal pumps, one 14-inch horizontal acting pump, and one 10-inch horizontal acting pump, with ample boiler capacity to furnish all the steam required to the engines.

It was found that the full capacity of two 12-inch centrifugal pumps was necessary to carry off the leakage after the water surface had been lowered about 7 feet only, the bottom being about 10 feet below Davis Island Pool. Leakage through the cofferdam was comparatively insignificant, although it was evident that the puddling material was not of the best quality. The principal inflow of water came apparently from beneath the dam, and the entire area of the bottom within the inclosure gave evidence of the boiling up of springs. The inflow was not restricted to any particular locality, but occurred throughout the entire length of the cofferdam. One large leak near the northwest corner of the dam and on the river face, rising apparently from a point in the bottom about 4 feet inside the dam, having been located early in the operations, an attempt was made to suppress it; clay and gravel were thrown over on the river side of the dam until the summit of the deposit reached the level of the water outside, the slope being probably one-third. When the first load of clay was thrown in, immediately opposite the point where the water emerged inside the dam, the clay reappeared almost immediately with the inflow of water, showing that it had reached the source of the inflow. After several hours' work the

leak was practically closed, but soon afterwards reopened, and although about 150 cubic yards of similar material was afterwards dumped upon the same spot the inflow continued to increase. It was evident from this that the source of supply was farther out from the dam than the slope of this deposited material could reach; in other words, that the whole bottom is permeable. Similar streams flowed in at many points, and the bubbling up of springs remote from the side of the cofferdam throughout the bottom, as well as the inflow from the porous bank of the river, was almost universal.

Since this condition of affairs is found when the water surface has been lowered only 7 feet below Davis Island Pool, and the excavation must be carried down to a depth of 20 feet below the Davis Island Pool, and the pumps at least 2 feet lower, no further or more exhaustive experiment with this dam is necessary to demonstrate the impracticability of making use of it for laying the foundations of the lock. Sheet piling around the exterior of the cofferdam might still be tried, but in my judgment would prove a failure and only delay still further and add further unnecessary expenditure to this much delayed work. The area inclosed by the cofferdam is about 600 feet long by 200 feet wide, embracing about 3 acres of river bottom.

A deposit of sand and gravel overlies the rock at this site, having a thickness of about 35 feet, the rock being 45 feet below the pool level of Davis Island Dam. This deposit has been worked for a great many years by sand diggers to procure sand and gravel, the operation resulting in eliminating the sand and fine gravel and leaving the large stones and coarse gravel in place. To some extent the river may renew the fine material, but it would rather be superposed, and the result can not fail to be to render this deposit far more permeable to water—probably to establish channels of easy flow through the mass of the deposit. This work has been carried on to a depth of about 28 feet below Davis Island Pool level, the best material being obtained at the greatest depth.

In sinking a well inside the river bank at the site of the lock, at a point where a fill had been made over the original river-bed deposit, a boring was obtained through this deposit where it had probably never been disturbed. The boring showed sand increasing in fineness to the rock, which was overlaid by a stratum of quicksand. At the depth of 30 feet below pool level this sand is fine enough to insure a fair degree of impermeability.

There is evidence, however, of an underbed flow of water in places in the Allegheny River, quite independent of the burrowing of sand diggers, and of very different water from that which flows between the banks of the river. * * *

In designing the foundations of the Herr Island Lock and Dam, I have proposed to reach the undisturbed deposit, 30 feet below pool level, by the use of a triple lap of stout oak piling, driven below the excavation for the foundation masonry, and I consider it indispensable to any plan of construction that this depth should be attained, so as to cut off the underbed flow of the river, through the open drains left by the sand diggers. The use of a cofferdam is impracticable for the foundation, and this must be laid under water. It will not be possible, as shown by experience here, to make satisfactory use of sheet piling; the great depth of water will add too much to the great difficulty of driving sheet piling satisfactorily, under ordinary conditions, in this mixture of cobblestone, bowlders, and gravel. For this reason the masonry itself must be carried down to the depth of 30 feet below pool level. If an impermeable horizontal stratum of concrete, covering the whole area of lock foundation, be put down at this level, being deposited under water after dredging out the sand and gravel, all foundation walls may be started from this stratum and built up by the same process to such a height that when the dredged sand and gravel is redeposited to this height upon the foundation stratum of concrete the mass will have sufficient weight to balance the head of water to which it may be subjected for the purpose of completing the work from this point within a cofferdam, the water being pumped out. This cofferdam will then be contiguous to the exterior face of the foundation walls of the lock—a prolongation above water of the masonry cup formed by these walls and the foundation stratum of concrete. After pumping out there can be no percolation of water except through the material of the cofferdam.

There are some important advantages resulting from this type of foundation. The uncertainties of sheet piling are replaced by the known qualities of masonry, resting upon a foundation bed that is open to inspection. In the first design, the expensive concrete floor has been minimized in thickness so as to produce a rupturing strain under possible conditions of navigation, and to prevent the pumping out of the lock chamber while the Herr Island Dam is up. With the present design there is no rupturing strain on the floor, and the lock chamber can be pumped out at any stage of water that the lock walls will keep out.

This modified plan was approved September 6, 1894, and bids for dredging advertised September 8, 1894; opened September 18, 1894; contract awarded to the Drake & Stratton Company, of Pittsburg, Pa.,

September 20, 1894. The work of dredging was commenced September 26, 1894, and completed on November 19, 1894. The driving of piles for the concrete forms was then attempted, with the hope that an open winter might permit the laying of concrete. To this end preparations were made for preventing the freezing of the concrete and contracts made for the delivery of the necessary material. Three thousand barrels of cement was received and stored and 41 piles driven. High water compelled the discontinuance of work on December 27, 1894, and the winter setting in soon after with unusual severity compelled the abandonment of any further attempt until the following season. During the winter a phenomenal ice gorge formed in the Allegheny River above Pittsburg and large masses of ice passed over the cofferdam, entering the inclosure and filling it nearly to the bottom. This resulted in the destruction of the piles which had been driven, but was beneficial in an unexpected way. The dredging out the site for the foundation in 30 feet of water had resulted in such a thorough washing of the material removed that a deposit of fluid mud was left in the bottom measuring, after a week or more of settlement, about 2 feet in depth. It was not possible to remove this with the dipper dredge and a pumping dredge was hastily rigged up from the plant on hand, but could not be completed before the winter set in. When work was resumed on April 1, 1895, it was found that the scour beneath the accumulated ice had removed this deposit completely. The ice gorge moved out after a long thaw, so soft and rotten that no harm was done, though the masses were in some cases 15 feet in thickness, large blocks of 6 or 8 feet in thickness being deposited upon the top of the cofferdam. Following this, however, and just before the resumption of operations, a flood in the Allegheny undermined and emptied about 150 feet of the river wall of the cofferdam, carrying the material into the excavation for the lock foundation. In all, 4,738 cubic yards of sand and gravel was carried into the excavation by the winter floods. As soon as the dredge could be put to work, May 9, 1895, the redredging of this material was commenced and completed May 25, 1895. Contrary to expectations no deposit of mud resulted, and the work of driving piles for the concrete forms was commenced as soon as the pile driver could be gotten into position, June 4, 1895. The driving of piles has been completed, and the completion of the forms, with the aid of divers, is now in progress. The accompanying sketches show the general features of the modified plans for this work and the methods of construction adopted.

The piles are first driven, being weighted at the lower end and hung by means of a staple in the center of the head from the leads of the pile driver, then lowered to near the bottom and accurately fixed in position by intersecting transit lines. After the driving of the piles two feet of each projects above the water surface. They are first accurately spaced and approximately aligned by means of temporary wale pieces spiked on at the water surface. The bottom stringers are now attached to the piles, each piece being 4 by 6 inches by 12 feet, and having three 9-inch spikes in each pile. The upper stringer is next put in place as a stiffening stringer. It consists of two pieces of 4 by 6 inches by 20 feet, one of which is placed upon the inside of the piles, with the 6-inch dimension vertical, the other upon the outside of the piles, with the 6-inch dimension horizontal. They are bolted together with three three-fourths-inch iron bolts. These are framed together at the surface of the water, then lowered to position and the nuts set up tight by a diver, who sits upon a platform suspended from the divers'

boat. Each pair of stringers covers three piles, and the series overlap one another at each third pile. From this stringer is suspended the swinging platform by means of which the middle stringer is put on. The planking is vertical, consisting of 2 by 12 inches by 20 feet hemlock, and is put on by two divers working together, one at the bottom stringer and one at the middle stringer. These are followed up by a surface party with a "shotgun," by means of which the planks are nailed to the upper stringer at a depth of 9 feet below the surface. Last of all the final alignment is perfected by shoring up from the outside of the form those piles which lean outward from either face of the wall, and introducing spacers to separate those piles which lean inward. These spacers are 8 feet under water, and their position is indicated by floats which rise from the extremities on the line of the inner and outer planking. Other floats of a similar character at intervals along the line of the planking serve to indicate its position after the piles have been cut off, and to indicate any change which may occur during the progress of depositing concrete. All piles are cut off 7 feet below water, so that the forms may not be disturbed by crane boats or other moving objects during the process of depositing concrete.

This work has been under the immediate supervision of Mr. J. W. Arras and Mr. I. V. Hoag, jr., assistant engineers.

[Extract from report of Mr. J. W. Arras.]

The prevailing conditions during the year were exceptionally favorable for the prosecution of this work. From July 1, 1894, until the end of the working season, late in the month of December, the delays due to high water aggregated less than one week; although the winter was a severe one, yet no disastrous freshets or ice gorges occurred; and after the usual spring freshets had subsided, about April 20, the water continued at a favorable stage until the end of the year.

At the beginning of the year two 12-inch vertical centrifugal pumps, and one 14 by 16 inch engine to drive them had been set and everything was in readiness for removing the water from the cofferdam inclosure. On July 7 the pumps were started and the water lowered 20 inches, when, it being apparent that the engine in use had not sufficient power to drive two pumps at their full capacity, and that at least that number, and probably more, would be required to empty the inclosure, owing to heavy leakage, the machinery was shut down and the second engine ordered. This engine arrived from Erie, Pa., on July 23, and a few days later had been set, and the pumping plant was again started. When the water had been lowered 38 inches the leakage counterbalanced the discharge of the pumps, and they were again stopped and a third engine and pump ordered. On August 7, the pump was received and was immediately put in place. The engine, however, did not arrive until August 21. Two days later the three 12-inch pumps were put in operation, and on August 24 the Monongahela Navigation Company's plant, consisting of one 18-inch and one 12-inch Blake pumps, was added. After seven hours pumping the water had been lowered 7 feet, and below the reach of the navigation company's pumps. The work of lowering the Government's pumps was then begun, and after two days endeavor the water in the inclosure was found to stand 8 feet 2 inches below the level of the Davis Island Pool on the outside.

At this time the leakage was equal to the discharge of two 12-inch centrifugal pumps at their full capacity, estimated at not less than 1,000,000 gallons per hour. You then decided to abandon the idea of maintaining a dry cofferdam inclosure during the construction of the foundation of the lock, and the machinery was stopped and the inclosure permitted to fill with water, which required about twenty-four hours. The greater part of the leakage under the dam was doubtless due to the previous operations of sand diggers in that locality. These diggers remove the material of which the river bed is composed to a depth of nearly 30 feet, and after screening out the sand replace the coarse material into the excavations from which it was taken. Such being the condition of at least a portion of the river bed on which the cofferdam was erected, and no attempt having been made to shut off the free flow of water through the coarse material by driving heavy sheet piling around the structure, the above conclusion is deemed a reasonable one.

After the abandonment of the original plans, and your plan for building the foundation of the lock under water had been determined upon, the pumping machinery was dismantled and removed to the storehouse, and on September 7 a 50-foot section of the lower end wall of the dam was removed to permit of the passage of floating

craft in and out of the inclosure. The removal of the material for the lock foundation was let to the Drake & Stratton Company, Limited, of Pittsburg, who on September 26 began operations with one dredge on the excavation. This excavation was, approximately, 90 by 404 by 20 feet deep, exclusive of the slopes. Fair progress was made, but in order to hasten the work a second dredge was put to work on October 16. On November 19 this work was completed, the depth varying from 29 to 31.5 feet below the level of the Davis Island Pool, and the slope standing at about 1 foot vertical on 1½ feet horizontal.

A few days later it was discovered that large quantities of mud, which had been carried in suspension during the process of dredging, had settled on the bottom of the excavation. A careful examination developed the fact that its depth varied from a few inches to 2½ feet, the entire quantity being estimated at 1,211 cubic yards. The quantity of material excavated by the dredges, exclusive of the space occupied by the mud, was 38,178 cubic yards.

Upon completion of the excavation steps were taken to put in place the piles to which to attach the form for the concrete foundation. Two hundred and fourteen piles 40 feet in length were required. To enable the diver to set the piles properly at the bottom, a stake driver was constructed, consisting of a steel foot attached to 35 feet of 3-inch pipe, on which was run a circular iron hammer, and a stake 2 by 4 inches by 5 feet, properly marked, driven near the location of each pile to designate its position. On December 1 the stakes were all in place, and all was in readiness for the driving of piles. A slight rise of the water, however, delayed this work until December 21, when operations were begun. On December 27, when 40 piles had been driven, the severity of the weather caused suspension of active operations, which continued during the remainder of the winter.

On January 7, 1895, the first break of the ice occurred, accompanied by a 26-foot rise, principally Monongahela water. Although some difficulty was experienced in protecting the plant only a few loose piles were lost. Subsequently heavy ice formed in the cofferdam inclosure, and when the ice again broke, on March 25, all but three of the remaining piles were either broken off or raised by the water's action.

No further damage from ice being anticipated, preparations for the immediate resumption of operations were made. From an examination of the bottom of the excavation it was developed that considerable deposits of sediment had formed during the winter. This condition having been anticipated, and the material being loose and easily handled, a pumping dredge had been constructed of a cheap open scow, 20 by 70 by 3 feet gunwale, on which were installed an 80-horsepower boiler, a 14 by 18 inch engine, and a 12-inch centrifugal pump, with the necessary suction and discharge pipes. On April 10, when the dredge was about finished, a 22-foot freshet occurred and continued for several days. After the water had subsided the dredge was put in operation, but the clogging of the discharge pipe with cobbles caused so much delay that the plan was abandoned, and on May 9, Drake & Stratton Company's dipper dredge was again set to work. On May 25 the material deposited during the winter had been removed, together with the parts of the piles remaining in the excavation. The Jutte & Foley Company, to whom the driving of the piles had been let, resumed operations on June 4 and completed that part of the work on June 22.

When sufficient piles were in place the construction of the concrete form was begun. An attempt was made to attach the sheeting to the piles in panels to be lowered into the water after completion on the surface. These, however, proved to be unwieldy under water and the plan was modified, the stringers being first attached to the piles and the sheeting fastened thereto afterwards. On this work four diving parties are engaged, and at the close of the year about two-thirds of the stringers were in place.

During the year important additions to the construction plant have also been made. A contract for the furnishing of cement for the concrete foundation having been let, and the buildings on the ground not affording sufficient storage room, three additional buildings, each 18 by 50 feet, were erected after the lot had been raised 4 feet above its former level, or to an elevation of 1 foot above extreme high water, to avoid any danger of loss to the contents in the event of an unusual freshet. Two thousand cubic yards of material was required to make this embankment, all of which was furnished free of charge to the United States by contractors and manufacturers of Pittsburg. A wooden tank of 100 barrels capacity for storage of water for use in mixing concrete was erected at an elevation of 20 feet above the lot level. A concrete mixing plant consisting of two cubical mixers of 1½ cubic yards working capacity each and a 9 by 12 inch vertical engine to operate them was erected. This machinery is supported by a pile structure so situated as to enable the passage of small scows underneath for the conveyance of the concrete to its final place in the foundation. Over the mixers is built a series of bins for storage of the materials composing the concrete.

For transporting the concrete 9 small scows 8 by 20 feet were procured, and for lowering it to place, as also for general work, a larger scow, 20 by 70 feet, fitted up as a crane boat, being equipped with a derrick and a small boiler and hoisting engine, was provided. Six iron tubs specially constructed for depositing the concrete under water were secured, as were also as many plain iron tubs for handling loose materials. An iron derrick for handling materials from the river, railroad, concrete mixer, and yard was erected on the lot. A freight-receiving platform and about 400 feet of narrow-gauge tramway, with the necessary turntables, etc., for conveying materials in the yard, were constructed.

The valves, 16 in number, for filling and emptying the lock were secured. During the month of November 3,000 barrels of American natural hydraulic cement, to be used in making concrete for the foundation of the lock, were received and stored in the buildings previously erected for its reception. The usual tests were made during the winter. The furnishing of 284 cubic yards of stone in the rough for the heads of the lock walls and for the miter walls was let to Messrs. Patton & Gibson, of Pittsburg.

The cofferdam for the lock, which was erected in 1893, withstood the second winter's ice and freshets, suffering but slight injury. During the rise which occurred in April the outer wall near the head undermined owing to its proximity to the excavation for the outer-head buttress of the lock and 800 cubic yards of the gravel filling washed out. The framework, however, remained intact. The repair of this work is being deferred until the construction of the lock foundation has progressed further.

A very careful line of levels was established between the Davis Island Dam, about 6 miles below, and the dam at Herr Island.

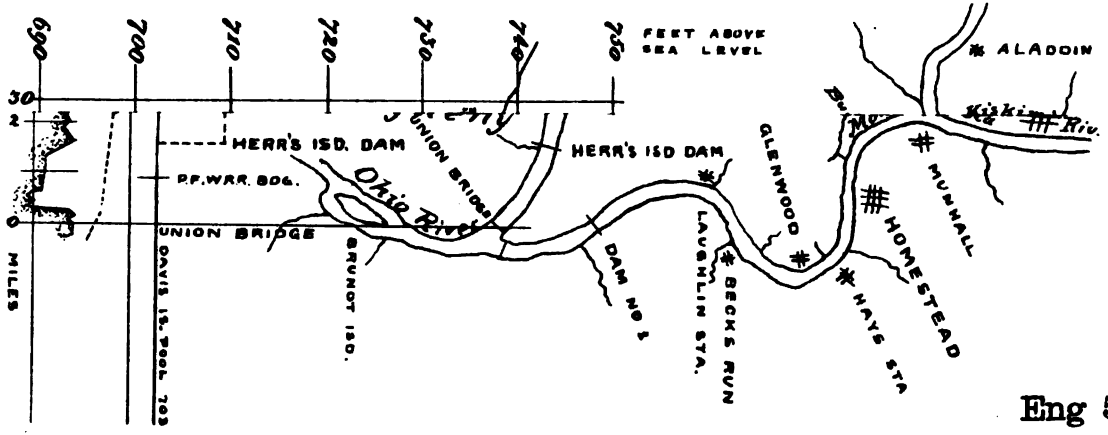
Money statement.

July 1, 1894, balance unexpended		$78,742.59
Amount appropriated by act of August 17, 1894		40,000.00
		118,742.59
June 30, 1895, amount expended during fiscal year		38,333.78
July 1, 1895, balance unexpended		80,408.81
July 1, 1895, outstanding liabilities	$6,766.16	
July 1, 1895, amount covered by uncompleted contracts	18,256.85	
		25,023.01
July 1, 1895, balance available		55,385.80
Amount (estimated) required for completion of existing project		444,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		300,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals for 2,250 net tons, more or less, of American natural hydraulic cement received in response to advertisement of July 31, 1894, and opened by Maj. R. L. Hoxie, Corps of Engineers, August 20, 1894.

No.	Name and address of bidder.	Bid for cement. Per 100 pounds.	Per barrel.	Per 2,000 pounds.	Total.	Brand of cement.
		Cents.	*Cents.*			
1	The Lawrence Cement Co., New York, N. Y.	§ 32	.....	.....	*$14,400.00	Manhattan.
		§ 35	.....	.....	15,750.00	Hoffman.
		† 38	.....	.....	17,100.00	Cumberland.
2	B. Wallis & Co., Baltimore, Md.	† 32½	.....	.....	14,535.00	Do.
		§ 27½	.....	.....	‖ 12,397.50	Do.
		¶ 47½	.....	.....	‖ 21,214.29	Do.
3	The Crown Cement Co., Bellaire, Ohio	.....	65	.....	‖ 10,446.43	
4	The Globe Cement and Lime Co., Wheeling, W. Va.	.....	63	.....	‖ 10,125.00	
5	National Cement Co., Limited, Pittsburg, Pa.	.....	.....	§ $6.86	‖ 15,435.00	Cumberland and Potomac.
		.....	.....	¶ 8.23	‖ 18,517.50	

* Recommended for acceptance.
† In barrels.
‡ In paper sacks.
§ In bulk.
¶ In cloth sacks.
‖ Informal.


690
700
710
720
730
740
750
FEET ABOVE SEA LEVEL
30
2
0
MILES
HERR'S ISD. DAM
P.P.W.R.R. BDG.
UNION BRIDGE
Ohio River
UNION BRIDGE
BRUNOT ISD.
DAVIS I.S. POOL 703
HERR'S ISD DAM
DAM NO 1
LAUGHLIN STA.
BECKS RUN
GLENWOOD
HAYS STA
HOMESTEAD
MUNHALL
ALADDIN

Eng 54

stract of proposals for dredging about 63,000 cubic yards in the Allegheny River, received in response to advertisement dated September 8, 1894, and opened by Maj. R. L. Hoxie, Corps of Engineers, September 18, 1894.

Name and address of bidder.	Price of dredging, per cubic yard, measured in place.	Total.
	Cents.	
Hulings Bros., Pittsburg, Pa	15.9/10	$10,017
Iron City Sand Co., Pittsburg, Pa	15	9,450
Monongahela and Western Co., Pittsburg, Pa	14.99/100	9,387
J. K. Davison & Bro., Pittsburg, Pa	15 1/2	9,765
The Drake & Stratton Co., Limited, Pittsburg, Pa	14	*8,820

* Recommended for acceptance.

stract of proposals for 284 cubic yards of stone for lock in the Allegheny River at Pittsburg, received in response to advertisement dated April 11, 1895, and opened by Maj. R. L. Hoxie, Corps of Engineers, May 11, 1895.

Name and address of bidder.	Price per cubic yard.	Total.
Jutte & Foley Co., Pittsburg, Pa	$10.00	$2,840.00
Casey & Sherwood, Groton, Conn	19.98	*5,674.32
A. O. Venable, Atlanta, Ga	23.75	*6,745.00
Jos. Gianini, Allegheny, Pa	6.50	1,846.00
Lawrence L. Wilson, Ellwood City, Pa	8.89	2,524.76
Driver & Ranson, Pittsburg, Pa	9.48	2,692.32
Patton & Gibson, Pittsburg, Pa	6.42	†1,823.28

* Granite. † Recommended for acceptance.

List of contracts in force during the fiscal year ending June 30, 1895.

Name of contractor.	For—	Entered into.	Remarks.
The Lawrence Cement Co	Cement	Sept. 4, 1894	In force.
The Drake & Stratton Co., Limited	Dredging	Oct. 6, 1894	Do.
Patton & Gibson	Stone	June 6, 1895	Do.

D D 8.

ELIMINARY EXAMINATION OF TIONESTA RIVER (CREEK), PENNSYLVANIA.

[Printed in House Ex. Doc. No. 81, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, ted September 18, 1894, by Capt. R. L. Hoxie, Corps of Engineers, the results of a preliminary examination of Tionesta River (Creek), nnsylvania, made to comply with the requirements of the river and rbor act of August 17, 1894.

It is the opinion of Captain Hoxie that Tionesta Creek is worthy of provement by the General Government, but Col. O. M. Poe, Corps Engineers, the division engineer, states that he is unable to concur Captain Hoxie's conclusions, and he is, therefore, compelled to report adverse opinion.

Concurring in the views of Colonel Poe, I am of opinion that Tionesta Creek is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., September 18, 1894.

GENERAL: In compliance with letter from Office of Chief of Engineers, dated August 20, 1894, I have the honor to submit report of a preliminary examination of Tionesta Creek, Pennsylvania.

An examination of this stream, with a view to ascertaining probable cost of a survey and project for improvement, was made in 1882, in accordance with the requirements of the river and harbor act approved August 2, 1882. From the report made of this first examination, as well as from that of Mr. I. V. Hoag, jr., assistant engineer, transmitted herewith, it appears that Tionesta Creek is a waterway of considerable importance to the country which it drains. The output of lumber and timber from this section of country is annually about 40,000,000 cubic feet, and it has been estimated that this rate of output could be maintained for twenty-five years.

Since the date of the first examination, which did not result in any appropriation for the benefit of this stream, parties who were principally interested have expended a considerable sum of money in removing some of the obstructions to the rafting of lumber and timber. For detailed information attention is respectfully invited to the Report of Chief of Engineers of 1884, pages 1704–1707.

No survey is needed and no further examination. A project with estimate of cost can be prepared from the data now on hand. In my opinion this river is worthy of improvement by the General Government, for the reasons above mentioned.

Very respectfully,

R. L. HOXIE,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[Fifth indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 16, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

From these papers, together with those referred to, it appears that the navigation of Tionesta Creek is confined to the floating of rafts of logs and sawed lumber. It is also apparent that such improvement of the creek as is proposed has for its only object to facilitate the movement of rafts. Any improvement having in view navigation of boats

uld only be made at a cost so far beyond any possible benefit as to eclude it.

The interests involved are so purely local, and the amelioration ught is so strictly confined to a single interest, that I find myself iable to concur in the conclusion herein embodied, that Tionesta eek is worthy of improvement by the General Government. I am erefore compelled to report an adverse opinion.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

REPORT OF MR. I. V. HOAG, JR., ASSISTANT ENGINEER.

GOSPORT, PA., *September 7, 1894.*

CAPTAIN: In compliance with your instructions, and in accordance with river and rbor bill of 1894, I have on the 5th instant made an examination of Tionesta eek, Pennsylvania, and find the facts as set forth in report of my previous examiion of this stream, October, 1882, Chief of Engineers' Report, vol. 3, 1884, p. 1704, bstantially unchanged.

Upon proceeding to Tionesta I made the purpose of my visit known to some repreitative people and desired to know the object of this examination, and from them arned that the initiative of this inquiry came about in a general and public petiin of the citizens of Tionesta to the Hon. G. W. Kribbs, M. C., asking for some tention to the merits of Tionesta Creek during the consideration of the pending ver and harbor bill. None of these people had ever seen my report of 1882 on this bject. This I showed to them, and it was read by Messrs. T. D. Collins, James Muse, A. Randall, Lyman Cook, and others. All agreed that the facts were impartially ven, and that it received their unqualified indorsement, and that all they would sire would be to have that report revived and acted upon.

During the past twelve years some changes have occurred here, and a spirit of ogress is apparent. The sawmills have kept pace with all improved machinery id plants have been enlarged, and the principal operators have recently united in ie construction of a standard-gauge railroad, connecting with the Western New ork and Pennsylvania Railroad at Hickory, Pa., from which point it leaves the Alleeny River, and crossing the intervening country, enters the Tionesta Valley at the outh of Ross Run, 12 miles from the mouth of Tionesta Creek, from which point follows the creek, both up and down the left bank, with spur branches to the varis mills. The total present length of this road, I am informed, is about 27 miles.

I went by horse and buggy, following the creek from its mouth to Newton, a disnce of 16 miles. Above that point I was assured that absolutely no change was to recorded from my previous report. At very many points along the route travsed frequent masses of rock could be removed to the material improvement of fer navigation.

Many of the mill owners and other operators, having despaired of attention by ie Government to their repeated requests, have at various times recently underken at their own expense some of the improvements asked for, and in this conection, Panther Rock, referred to in Report of 1882, was in 1888 removed by T. D. ollins & Co. at considerable expense to themselves, and during 1893 Messrs. Colns, Darragh & Co. expended $194.50 in removing rock obstructions from the creek etween Nebraska Mills and Tionesta, a distance of 7 miles, and perhaps the best ridence of the necessity and justness of the claim of Tionesta Creek to some conderation, the fact of the expense incurred by the people themselves in the attempt reduce the difficulties of navigation may be sufficient argument.

* * * * * * *

Very respectfully, your obedient servant,

I. V. HOAG, JR., *Assistant Engineer.*

Capt. R. L. HOXIE,
Corps of Engineers, U. S. A.

D D 9.

ESTABLISHMENT OF HARBOR LINES AT PITTSBURG, PENNSYLVANIA, AND ON BOTH SIDES OF THE OHIO RIVER AS FAR DOWN AS DAVIS ISLAND DAM.

CHAMBER OF COMMERCE OF PITTSBURG,
Pittsburg, Pa., December 8, 1890.

SIR: At the meeting of the board of directors of the Chamber of Commerce of Pittsburg held this day, the annexed report of the committee on rivers and harbors was presented and unanimously adopted.

Very respectfully yours,

G. FOLLANSBEE,
Superintendent.

Hon. REDFIELD PROCTOR,
Secretary of War.

RESOLUTION OF THE CHAMBER OF COMMERCE OF PITTSBURG.

PITTSBURG, PA., *December 8, 1890.*

Whereas the river channels, within the limits of the United States Government dam at Davis Island and the harbor of Pittsburg, are being seriously damaged by the dumping of waste material from mills, furnaces, and other sources; and

Whereas, this trespass upon river rights has been carried to such an extent that hundreds of acres of former waterways have been filled up by railway embankments and deposits from mills and other sources of refuse, and the places so filled appropriated for personal use by those thus trespassing, to the serious detriment of river interests, increasing peril of life and property by narrowing and obstructing the channel ways; and

Whereas, by this long-continued encroachment upon harbor facilities, the original shore lines have been so destroyed as to render it quite impossible for the officers of the Government to prevent this wanton violation of navigable rights; and

Whereas, these waterways are the recognized highways of trade and travel belonging to the people, and ought to be protected from seizure and appropriation by the few for private use; and

Whereas, the present Congress, at its first session, empowered the Secretary of War to have harbor lines established where the exercise of such authority becomes necessary for the preservation of harbors and the protection of navigable waters connected therewith: Therefore

Resolved by this chamber, That we do most earnestly appeal to the Honorable Secretary of War to enforce such measures as he may think best to have established, at an early day, harbor and river lines within the limits of said Government dam at Davis Island and the harbor of Pittsburg and at all other points that immediately affect the navigable waters connected with this city.

From the minutes:

[SEAL.]

G. FOLLANSBEE,
Superintendent.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 22, 1895.

GENERAL: The Board of Engineer Officers constituted by Special rders, No. 87, headquarters Corps of Engineers, December 20, 1890, amended by Special Orders, No. 3, paragraph 11, Adjutant-General's ffice, January 5, 1892; by Special Orders, No. 50, headquarters Corps Engineers, October 15, 1892, and by Special Orders, No. 18, para-raph 2, headquarters Corps of Engineers, April 24, 1893, to consider id report on the subject of harbor lines in Pittsburg Harbor and on oth sides of the Ohio River as far down as Davis Island Dam, have e honor to submit the following report:

At the outset it would seem proper to state some of the circumstances hich have caused such length of time to be consumed in the proper vestigation of, and report on, what has been found to be a very com-ex problem.

It was assumed that a fair solution of the problem of fixing the har-or lines would consider the wishes, as nearly as possible, of all parties terested in the matter, which included property owners on the banks id river interests. This of course necessitated many compromises, as many cases interests were conflicting. The industries lining the anks of what is called the harbor of Pittsburg, at the present day, e of national importance. Many of them, involving investments of undreds of thousands of dollars, are built on made ground, far within ie original bed of the river, and to arbitrarily set back the bank nes in such cases might cause an immense loss to vested interests. n the other hand, the continued encroachments in the bed of the ver have undoubtedly increased the cost and danger of shipping by ver, particularly at high stages of water, and changed the flow of oods. The Pittsburg coal-shipping industry, which sends its coal to arket by river, is the greatest in the country. To paralyze this is to jure the entire Ohio and Lower Mississippi valleys.

The Board, therefore, determined that it would be necessary to con-truct accurate maps on a large scale, based on accurate surveys of each iver within the adopted limits. These would show exactly the existing tate of affairs, viz: Height of bank at various points above low water, ontour of river, and location of all existing plants, railroads, and ridges. The total length surveyed by river is about 26 miles, or 52 iles of bank line; and, to secure the requisite accuracy in the field ork and platting of the maps, a long time and considerable expendi-ure of money was needed. Meantime all parties concerned were to ave everything in statu quo.

Next it was necessary to obtain the opinions of all parties concerned. s might be expected there were many, and from the mass of conflict-ng claims to work out a feasible plan has required a great deal of tudy, and in a number of cases it was found advisable to change lines fter they had been laid down. In addition to this, but one member of he original Board still remains (it having been necessary to change he senior member once and the junior twice), and the assistant engi-neer in immediate charge of the work was seriously ill for a number of nonths.

HISTORY.

The Board first met in open session at Pittsburg on January 6, 1891, he three members at that time being Lieut. Col. W. E. Merrill, Maj.). W. Lockwood, and Lieut. C. E. Gillette, Corps of Engineers.

After a preliminary consideration of the subject the Board directed the surveys and preparation of the maps, and adjourned.

The surveys and maps having been completed, other public meetings were held at Pittsburg November 8 and 9, and December 20 and 21, 1893, the membership of the Board being the same as at present. At these meetings all parties interested were requested to explain by drawings, or otherwise, what was desired. A public examination of the bank lines was made by the Board December 21, 1893. Representatives of the Pittsburg Coal Exchange and of the leading manufacturing industries and railways were present at all public meetings, and presented their views both orally and in writing, but many parties interested in the subject did not appear at these meetings, and presented their claims afterwards.

Subsequently numerous meetings were held at Cincinnati for discussion and study, in order to obtain a satisfactory solution of the problem. A detailed description of the facts and principles which guided the Board may not only prove valuable for future reference, but is necessary to properly understand its conclusions in the present case.

LIMITS OF HARBOR LINES.

The harbor of Pittsburg, along both banks of which the lines are to be established, is considered to extend up the Monongahela River from its mouth to the city limits of Pittsburg, or the Homestead Bridge; and up the Allegheny to the public waterworks. The city limits of Pittsburg extend somewhat higher up on the Allegheny than these waterworks, but the river banks are practically unoccupied beyond, and to terminate the lines there appears satisfactory to everyone. On the Ohio the lines are required to be established, on both sides, as far down as Davis Island Dam.

LOCAL CHARACTERISTICS.

The Allegheny and Monongahela rivers, which unite to form the Ohio at Pittsburg, rise in districts widely separated, one in central New York, and the other in southern West Virginia. The climate and other features of the two river basins differ materially, and the resulting effects at Pittsburg and vicinity are extremely variable. The manufactories and railroads occupy a strip of comparatively low ground lining the river banks and which was originally only a few hundred feet wide. Back of this, on both sides of each river, rise precipitous hills from 300 to 600 feet high. The Point at Pittsburg was probably at an early day low ground, subject to overflow at ordinary stages. The Allegheny is at present an open river, but within the limits here considered will soon be converted into a pool at low water by the construction of a dam at Herr Island. The Monongahela is canalized for a considerable distance, Lock No. 1 being located about 2 miles above the Point Bridge. Pool water below is maintained by the Davis Island movable dam, which gives about +6 feet on the Market street gauge.

ENCROACHMENTS.

There being a lack of good sites suitable for buildings and transportation facilities along the rivers, it early became the practice to get rid of the refuse of mills by filling up the low bottoms where any existed, and afterwards by filling the river bed itself. Loud complaints of this

proceeding were made by the river men, and resulted in the establishment by the State of Pennsylvania in 1858 of a commission to fix lines in the endeavor to keep these encroachments within bounds. Little or no attention, however, seems to have been paid to these old State lines. A comparison of the maps of the present day with those of an earlier date shows astonishing encroachments on the river bed made by enterprising manufacturers determined to increase their acreage, and, at the same time, dispose of their refuse. The railroads, also, have taken their right of way out of the river and have gradually converted their trestling into solid ground. Between Sixth and Fifteenth streets, Pittsburg, the width of the Monongahela River has been reduced one-half; at other points about 30 per cent, and in one case a public levee has been occupied and entirely destroyed, the filling being continued outside, until two openings between piers of a neighboring bridge, and through which the river at low water always passed, have been permanently closed. Above and below Lock No. 1, Monongahela River, through which all the coal traffic passes, the encroachments have almost entirely closed the entrance to the inner and larger lock. On the Ohio the encroachments are less serious, but in the vicinity of the Glass House Ripple they have caused a great deal of complaint.

DEMANDS OF NAVIGATION INTERESTS.

In general, representatives of the navigation interests stated that if the lines were located so as to prevent future filling, and certain extremely bad points were removed they would be satisfied; but they demanded that the indentations of the bank lines, at high as well as low water, should be preserved as far as possible, on the ground that they were absolutely needed as harbors for the handling of their flats at various stages of the river. Property owners did not violently object to this basis of compromise, but there were a number of cases where a still further filling was desired. Where it was deemed absolutely necessary, and injury to navigation would not result, this has been provided for in the location of the lines.

METHODS PURSUED IN LOCATION OF LINES.

After giving careful consideration to all conflicting claims, it was not difficult to locate the lines roughly on the ground as it exists. But this is a small part of the problem. The main question is how to establish the bank lines so that they shall be absolutely fixed for all time and their location easily found. The importance of this matter becomes evident if one attempts to lay down the old State lines from their vague description.

The following general principles governed the Board in their conclusions on this subject:

First. The lines should be plainly and simply describable in order to avoid legal controversy. This permits only the use of regular plane lines and curves, and the Board decided to employ none except those having straight lines or circles for their horizontal projections.

Second. Not merely a line is needed, but the bank slope must be defined up to at least ordinary high-water mark. This can be done by establishing a second line at a known difference of elevation from the first, or by assuming a bank slope. The first plan was used by the old State commission, but the Board decided to adopt generally the second as being less confusing on the map. The slope usually assumed is that of one on three, which was believed to be safe with the material here

used for filling. The only cases of the use of two lines are where it was deemed best to vary from this fixed slope, as at the entrance of Lock No. 1, Monongahela River, and at public levees. At such points the slope is in some places determined by two lines, shown in projection on the maps, and whose difference of elevation is assumed to be 20 feet.

Third. The regulating line, in order that its relation to the top of existing banks may be clearly understood on the maps, should be, approximately, in a water surface for an adopted reading on some well-established gauge; and the greatest complication of all arises from the fact that this water surface can not be assumed as horizontal, and any line adopted will never show the water surface for a given gauge reading but once, unless the same conditions are repeated, which is particularly unlikely at Pittsburg, where three rivers affect the result. The gauge adopted by the Board is the old established one, in the Monongahela River at the foot of Market street, Pittsburg, its zero being quoted in the Signal Bureau reports, as 696.986 feet above sea level.

Fourth. What water surface is assumed as the regulating line is of minor importance, but there are advantages in taking a high stage rather than a low one. By so doing the line will usually be out of water and if cross dams exist in the river they may be considered as drowned, thus allowing the use of a single gauge for the entire harbor. In the present case, if a low-water line were adopted it would necessitate the use of two gauges, one above and the other below Dam No. 1, Monongahela River. The Board therefore assumed throughout a reference line lying as nearly as possible in a plane tangent to the water surface when the Market-street gauge reads +20 feet.

Fifth. To continue the bank slope of 1 on 3 indefinitely above ordinary high water would be absurd as in many cases this would cut off the tops of existing buildings and prevent building on the slope. The Board therefore conclude to carry the slope only up to the 20-foot stage, ordinary high water, the top of the slope being the reference line. This stage is usually not much exceeded in floods, and then only for a few days. Any slope up to the vertical can be allowed at points above this limit.

Sixth. The lines, being purely imaginary, must be located and described so that no variation is possible; and a mere horizontal projection on an official map is not sufficient. Two horizontal coordinates and one vertical, all referring to fixed origins, are absolutely necessary.

The Board adopted for their horizontal coordinates a system of offsets from secondary base lines, which last could be located from certain fixed primary bases marked by permanent monuments.

It still remained necessary to obtain the vertical coordinate. As previously explained, the water surface adopted represented only one slope out of the many possible for a given gauge reading and, to be known, its elevation above a fixed plane of reference should be given at different points. To permit the use of the water surface at any stage by simply allowing for the difference of reading on the adopted gauge would only multiply the error, for it would not merely assume that a given gauge reading always corresponds to a given slope, but also that the river rose at all points exactly the same amount. This is so far from the truth that at the same point, at different times, results might be obtained differing by several feet; and every foot in elevation means 3 feet horizontally. The Board was therefore forced to decide that points of the reference lines should be connected with permanent bench marks in the rear, and these last with each other and with the Market

street gauge, by accurate lines of level. These bench marks should be on permanent monuments available for the use of neighboring property owners at any future time.

CONCLUSIONS.

The Board would therefore recommend that the continuous black line, shown in projection along each shore on the official map,* be adopted as fixing the limits of the top of the bank slopes in Pittsburg Harbor along the banks of the Allegheny, Monongahela, and Ohio rivers; that below this line a slope of 1 on 3 be adopted, except as hereinafter noted, this slope to be carried to the bottom of the river; that, in the exceptional cases where a different slope is required, an additional outer line to fix the plane of the slopes, and shown in horizontal projection on the maps, be used, its reference being assumed as 20 feet below that of the upper or main harbor lines; that within the limits named and in front of the adopted slopes no obstacle to the free flow of the water be permitted.

If the lines as laid down by the Board are approved, it is recommended that the Board be authorized to have the necessary surveys made and monuments placed to mark base lines to which the harbor lines may be referred, and an additional sheet or sheets will be added to the maps with necessary descriptions.

Respectfully submitted.

AMOS STICKNEY,
Lieut. Col. of Engineers.
D. W. LOCKWOOD,
Major of Engineers.
H. E. WATERMAN,
First Lieut. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 26, 1895.

Respectfully submitted to the Secretary of War.

The subject of the establishment of harbor lines for Pittsburg Harbor, and for both sides of the Ohio River as far down as Davis Island Dam, has been under consideration by a Board of Engineer Officers since December 20, 1890. The delay in making report has been due to the complex nature of the problem of fixing upon lines that would as near as possible meet the wishes of all parties interested in the matter. Conflicting interests necessitated many compromises, involving a great deal of study and a number of changes after lines had been agreed upon.

The Board has been careful and thorough in its consideration of the subject and submits the within report with a drawing,* in 21 sheets, to which attention is respectfully invited. The Board recommends:

That the continuous black lines, shown in projection along each shore on the official maps, be adopted as fixing the limits of the top of the bank slopes in Pittsburg Harbor, along the banks of the Allegheny, Monongahela, and Ohio rivers; that below this line a slope of 1 on 3 be adopted, except as hereinafter noted, this slope

* Omitted.

to be carried to the bottom of the river; that, in the exceptional cases, where a different slope is required, an additional outer line to fix the plane of the slopes, and shown in horizontal projection on the maps, be used, its reference being assumed as 20 feet below that of the upper or main harbor line; that within the limits named and in front of the adopted slopes no obstacle to the free flow of the water be permitted.

The Board further recommends that, if the lines are approved, authority be given to have the necessary surveys made and monuments placed to mark base lines to which the harbor lines may be referred.

I concur in the views of the Board and recommend that the lines as laid down by the Board be approved, and that the Secretary place his approval both upon this report and upon the title sheet of the drawing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *January 29, 1895.*

Approved as recommended by the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX E E.

IMPROVEMENT OF FALLS OF OHIO RIVER, OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

REPORT OF CAPT. JAMES G. WARREN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio River, at Louisville, Ky.
2. Indiana Chute, Falls of the Ohio River.
3. Operating and care of Louisville and Portland Canal, Kentucky.
4. Wabash River, Indiana and Illinois.
5. White River, Indiana.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 9, 1895.

GENERAL: I have the honor to transmit herewith annual reports concerning the works under my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

This work is located at the eastern or upper end of the Louisville and Portland Canal and was commenced under a project submitted by Lieut. Col. William E. Merrill, Corps of Engineers, in 1883. This was slightly modified in 1885, and again January 31, 1890, when the present project, submitted by Major (now Lieutenant-Colonel) Stickney and revised by a Board of Engineer Officers convened for that purpose, was approved.

The object of the improvement is to provide suitable space for traffic, and where tows may be properly arranged or made up preparatory to entering or leaving the canal.

The project provides for widening the canal on its northerly side, beginning at a point 725 feet below the Fourteenth Street Railroad Bridge, where the width of the canal is abruptly increased from 90 feet to 210 feet; this latter width is gradually increased through a distance of nearly 2,800 feet to 325 feet at the head of the canal proper, where the enlargement is expanded into a capacious basin 1,200 feet wide and practically parallel to the Kentucky shore. This basin will be limited at its westerly end by a bear-trap structure extending northward from the head of the new north wall for a distance of 800 feet. From the north end of this structure and extending to the south abutment of the middle chute opening of the cross dam a concrete dam 1,720 feet long will mark the northerly limits of the basin.

The work to be done under the original project and its subsequent modification and revision embraces the following estimated quantities:

Earth excavation	cubic yards..	283, 781. 31
Loose rock excavation	do....	13, 681. 86
Solid rock excavation	do....	316, 397. 02
Old river wall excavation	do....	21, 753. 39
Masonry new north wall	do....	16, 120. 30
Masonry new south wall	do....	3, 100
Old canal wall—3,550 linear feet to be removed	do....	7, 500
Slope revetment, south side of canal	do....	2, 300
Concrete dam—1,720 linear feet	do....	4, 822. 50
Guiding dike to be removed	linear feet..	1, 800
Cross dam to be removed	do....	1, 030
Bear-trap structures	do....	800
Cribs along north line of excavation		4

Of the above the following tabular statement shows what has been accomplished and that remaining to be done June 30, 1895:

Items.		Accomplished to June 30, 1895.	Remaining to be done June 30, 1895.
Earth excavation	cubic yards..	254, 123. 31	29, 658
Loose rock	do....	13, 681. 86	.....
Solid rock	do....	180, 245. 11	136, 151. 91
River wall, removal of	do....	21, 753. 39	.....
Masonry new north wall	do....	14, 710	1, 410. 30
Masonry new south wall	do....	.....	3, 100
Old north wall, removal of	linear feet..	3, 200	350
Slope revetment	cubic yards..	.....	2, 300
Concrete dam	do....	.....	* 4, 822. 50
Guiding dike, removal of	linear feet..	40	1, 760
Cross dam, removal of	do....	.....	1, 030
Bear-trap structures	do....	.....	800
Cribs, north line of excavation	number..	.....	4

* Equal to 1,720 linear feet.

At the beginning of the fiscal year the very small balance of available funds to the credit of this work precluded any active operations until the appropriation of August 17, 1894, became available. It was decided to apply these funds to completing the gaps in the masonry of the new north wall above the railroad bridge; removing the old canal wall on the south side of the enlargement; building a temporary crib dam 750 feet long between the lower end of the guiding dike and head of the new wall, whereby that portion of the work south of these structures could be thrown open to traffic; and such excavation work as it might be practicable to accomplish.

This plan having received the approval of the Chief of Engineers, preparations for active operations were at once begun. The necessary plant was overhauled, taken from the storehouses to the site of the

work and set up; trestles erected and tracks laid for stone, dump, and derrick cars. Ten-day proposals for furnishing the timber for the temporary dam and dimension stone for the wall were invited, received, and award made to the lowest bidder in each case.

The principal items of work accomplished during the season consisted of the removal of about 7,467 cubic yards of the old north wall of the canal, the stone from which was transferred to the south bank of the canal and piled for future use. Derrick boats were used in handling the stone and the barges upon which it was transported were towed between the points mentioned by the U. S. steamer *Major Mackenzie.* One thousand and thirty-two cubic yards of masonry was placed in the new wall, thus filling the gaps above Fourteenth Street Railroad Bridge and adding considerably to the unfinished portion west of that point, of which there remain about 325 linear feet to be built to connect the new and old walls. The stone for this masonry was handled with a derrick car improvised at slight cost, which could be easily and quickly moved from point to point, and for such reason proved highly satisfactory on account of the distance between the several gaps where the service of an appliance of this nature was necessary. The temporary crib dam 750 feet long (previously referred to in this report) connecting the head of the new north wall and the lower end of the guiding dike was constructed of oak timber and filled with stone; for this purpose 202,349 feet, B. M., lumber and 5,500 cubic yards stone filling was used. The dam is trestle faced in character; the bents were framed on the ground, slid into position, and raised by means of hand-power derricks, after which the side sheathing was attached, the top being left without decking. The object of its construction was realized, and that portion of the enlargement south of it has since been used whenever the stage of water permitted traffic to pass over the portions still unexcavated.

Other work during the season consisted of 43,724 cubic yards earth excavated and removed by dump cars and 5,192 cubic yards solid rock drilled, blasted, and broken up, but not removed. The drilling, except that for block holes done by hand, was accomplished by eleven steam drills, supplied with steam from two ordinary boilers of the locomotive type. The blasting was done with No. 3 forcite, small charges being used to avoid injury from flying rock to buildings on the south side of the canal. A frame house with metal roof for storing the tools and appliances used on this work and that of the Indiana Chute was built on the high bank near the lower end of the enlargement, and paid for proportionately from appropriations for both works. This, with repairs to the guiding dike, for which purpose 10,000 feet B. M. lumber was used summarizes the season's operations, which closed December 31, 1894.

The total amount expended under appropriations for "Improving Falls of Ohio River, at Louisville, Ky.," to June 30, 1895, is $777,417.73, of which sum $57,845.16, including outstanding liabilities, was expended during the past fiscal year. But the following statement will show more clearly the relation between the individual expenditures for the several projects and the aggregate, which amounts to the total just stated.

Amount expended under Colonel Merrill's projects and prior to adoption of the revised project of 1890	$293,754.88
Amount expended since adoption of the revised project of 1890 to June 30, 1895	350,662.85
Amount expended for enlarging basin at head of New Locks, for which work a separate project was submitted and first provided for in the river and harbor bill of August 5, 1886	133,000.00
Total	777,417.73

From this it will be seen that $133,000, while included in the statements of expenditures and the total thereof, was not, properly speaking, an expenditure in furtherance of the project for work at the head of the canal, but was in reality expended under a project separate and distinct from it, and for work entirely without its limits. It will also be observed that the sum of $350,662.85, including outstanding liabilities June 30, 1895, has been expended since the adoption of the revised project recommended by the Board of Engineers, whose estimate of cost of work recommended by it was as follows:

Earth excavation	$21,505.00
Rock excavation	370,750.00
Masonry in canal wall	122,669.00
Removing old canal wall	15,000.00
Removing dam and guiding dike	4,350.00
Building concrete dam (ref. 41), 4,822.50 cubic yards, at $4	19,290.00
Building wall with bear traps	80,000.00
Slope revetment south side of canal	9,600.00
Cribs north line of excavation	2,500.00
Contingencies	64,566.40
Total	710,230.40

The tabular statements of traffic and commerce accompanying the report for operating and care of the Louisville and Portland Canal, of which this work of improvement forms a part, exhibits the amount of river traffic and commerce directly interested in and passing this work during the past fiscal year.

This work of improvement, of unquestionable importance, has now been in progress for more than ten years, yet, owing to irregular and insufficient appropriations, navigation has not up to the present received any appreciable benefit from the work accomplished. I have therefore again to most respectfully urge the importance of large appropriations. As has been stated in previous annual reports, the cost of the work must be greatly increased by executing it under small appropriations. The nature of the area under improvement renders it imperative to remove every vestige of plant during the high-water period, and the percentage of cost for this transfer of plant to and from storage is inordinately increased when full advantage can not be taken of an exceptionally favorable season for prosecuting the work.

In view of these facts, it is recommended that the next appropriation for this work be not less than $300,000.

The following is a summary of all appropriations for the works to June 30, 1895, which includes the $133,000 expended in the enlargement of the basin immediately above the locks, referred to above:

By the act approved—	
July 5, 1884	$300,000
August 5, 1886	150,000
August 11, 1888	150,000
September 19, 1890	60,000
July 13, 1892	60,000
August 17, 1894	60,000
Total	780,000

Money statement.

July 1, 1894, balance unexpended	$427.43
Amount appropriated by act of August 17, 1894	60,000.00
	60,427.43
June 30, 1895, amount expended during fiscal year	57,566.97
July 1, 1895, balance unexpended	2,860.46
July 1, 1895, outstanding liabilities	278.19
July 1, 1895, balance available	2,582.27
Amount (estimated) required for completion of existing project	490,008.89
Amount that can be profitably expended in fiscal year ending June 30, 1897	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

E E 2.

IMPROVEMENT OF INDIANA CHUTE, FALLS OF THE OHIO RIVER.

Prior to January 31, 1890, there was no specific project for the improvement of this channel over the falls. The work was carried on with allotments from appropriations for improving Ohio River and under expenditure projects, having in view the removal of projecting rocks and straightening the channel, but no definite limits were prescribed within which work was to be done. On January 28, 1890, a Board of Engineers recommended the adoption of specific plans contemplating radical and permanent improvement within certain limits. These plans were approved January 31, 1890.

The object of the present project is to make this chute safely navigable for descending boats and large tows when the water is at or above a stage of 8 feet on the upper canal gauge, by providing a good channel 400 feet wide at the cross dam at the upper end, where a wooden crib dike 550 feet long marks the north side of the channel, and 700 feet wide at the lower end, where it will be defined by two stone dikes; one extending down stream 1,250 feet from Willow Point on the north side and the other from the upper side of Wave Rock on the south side, extending in a curve downstream 2,510 feet. A concrete guide wall is to be constructed along the north side of the channel for a distance of 870 feet above the railroad bridge. The project also contemplates the excavation of 19,109.62 cubic yards of solid rock from Willow Point, 17,550.09 cubic yards solid rock from Wave Rock, and the removal or displacement to grade of about 8,500 cubic yards solid rock and bowlders from that part of the channel above the railroad bridge.

On account of the small balance of funds available July 1, 1894, no work could be attempted until the appropriation of August 17, 1894, became available. An examination revealed the fact that considerable repairs to the cross dam were necessary as well as to the movable dam, from which several wicket frames had been torn entirely from their fastenings and parts of others badly damaged. The anchorage timbers, for a distance of 150 linear feet, were so much damaged as to require replacing. As soon as practicable after funds had become available the necessary material for these repairs was purchased and preparations for this and the excavation of rock from the channel begun. The breakwaters were commenced on September 18, 1894, and active operations continued until September 28, when high water caused a suspension for a few days, after which operations continued without interruption until

December 8, when lack of funds and high water caused further work to be suspended. During the season 1,736 cubic yards solid rock was blasted from the right hand reef, of which 1,376 cubic yards was removed from the channel and the remainder displaced so as to be below the established grade. Sixty-three thousand feet B. M. lumber was used in the repairs to the cross dam at points where the old timbers were rotten or had been torn away by the drift and ice. The movable dam was thoroughly repaired. In the original construction of this dam the sills and anchor timbers were bolted down to the bottom of a trench excavated in the solid rock for that purpose, so that when lowered the iron framework would be no obstruction to the passage of drift and ice. The spaces between the timbers and the sides of the trench were filled with concrete, excepting a distance of about 50 feet, in which the original surface of the rock was below grade. This part of the dam was badly broken; most of the woodwork, much of the iron, and all of the concrete work had disappeared. The timbers in this gap were replaced, missing parts of the ironwork supplied, and the entire damaged space protected by large flagging stones cut to fit the space between the timbers and the nearest projecting points of rock. This substitute for concrete was applied to the upstream side, and furnishes a strong protection for the weaker portions of the dam.

The work done was by hired labor and purchase of material under ten-day proposals. The drilling on the reef was done by hand. The number of holes drilled was 2,021 with an aggregate length of 4,000 linear feet.

For blasting on bare rock 40 per cent forcite was used, while for rock under water 75 per cent strength was used.

The only other work under this appropriation was its pro rata share in the construction of the warehouse referred to in the report for improvement of the Falls of the Ohio River, at Louisville, Ky.

The accompanying tracing exhibits the progress in excavation work during the past season. Of the work contemplated by the project of 1890 the following summary exhibits what has been accomplished and what remains to be done on June 30, 1895: The crib dike on the north side of the chute on the cross dam has been raised to Ref. 51 for a distance of 50 feet from its head downstream, and the remaining portion 524.3 feet, raised to Ref. 42, thus completing this particular item of the project. In the channel above the railroad bridge about 7,500 cubic yards of rock has been excavated and removed, or displaced to grade, leaving about 1,000 cubic yards to be so displaced. It is estimated that 11,800 cubic yards of rock, measured loose, has been excavated from Willow Point and used for building the dike immediately below that point to Ref. 22, with a top width of 40 feet and 1,234 feet long, leaving about 11,242 cubic yards rock, measured in place, to be excavated and applied to the completion of the dike on this side of the channel. At Wave Rock 12,064 cubic yards of rock, measured loose, has been excavated and applied to the construction of 400 linear feet of the dike on the south side of the channel to Ref. 20 and with a top width of 40 feet. There remain to be excavated from this rock and other points and placed in its dike about 9,470 cubic yards rock, measured in place. There also remain to be done the work of facing the two dikes just mentioned, estimated to be 18,819.87 square yards, and the construction of the concrete wall 850 feet long on the north side of the channel above the railroad bridge, for which it is estimated that 7,450 cubic yards of concrete masonry will be required.

As indicated in the beginning of this report, much work had been done on this channel previous to the adoption of the present project, resulting in materially improving parts of the channel, but sufficient

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U.S. Army.

data is not at hand to report the amount of work done prior to the adoption of the project of 1890, under which the estimated cost of work contemplated by it is as follows:

Raising wooden dike, Indiana Chute	$3,000.00
Concrete wall, stone facing, above bridge	29,800.00
Rock excavation, Indiana Chute, above bridge	20,000.00
Stone dikes, below bridge	63,800.00
Facing same	9,409.98
Contingencies	12,600.00
Total amount of estimate	138,610.97

The expenditures for work done before the adoption of the plans recommended by the Board amounted to $116,070.30, which amount included the various sums expended at different times for work on "Varble's Chute" and "Middle Chute." Since then the expenditures amount to $101,040.86; the sum of these two amounts, $217,111.16, being the total of expenditures to June 30, 1895, of which $19,773.30, including outstanding liabilities June 30, 1895, was expended during the fiscal year ending on that date.

A reference to the statements of traffic and commerce accompanying my report for the Louisville and Portland Canal will show the extent to which those interests are concerned, when it is stated that the canal locks can not be operated after the water reaches a stage of 12.7 feet, upper gauge, and traffic must pass through this channel which is now available when a stage of 10 feet is reached.

The following is a summary of all appropriations and allotments made for this work of improvement to June 30, 1895:

Act of—		Act of—	
July 14, 1880	$10,000	September 19, 1890	$25,000
March 3, 1881	50,000	July 13, 1892	35,000
August 2, 1882	35,000	August 17, 1894	20,000
July 5, 1884	10,000		
August 5, 1886	20,000	Total	220,000
August 11, 1888	15,000		

The importance of the work and reasons for early completion have been so fully set forth in previous reports that little remains to be said further than an earnest recommendation that the necessary funds be provided with which full advantage may be taken of favorable opportunity for prosecuting the work remaining to be done. Attention is invited to the fact that throughout the entire season of 1893, and until September, 1894, the work was without funds to further the progress of the improvement, barely enough being available to keep the dam and appliances used in connection therewith in repair.

In this connection it is earnestly recommended that the wording of appropriations for this work be made to read "Falls of the Ohio" instead of "Indiana Chute," as the latter is only a part of the falls, and it is equally necessary that work be done on the Middle Chute, the Varble Chute, and the dam across the head of the Falls. Much embarrassment has been caused by the apparent restriction of work to the Indiana Chute. The object is to make the Falls of the Ohio more navigable, and the funds ought to be available for application where they will do most toward the attainment of this object without delay. Had this been the case at the time the items of the appropriation of August 17, 1894, became available, work at the head of the canal could have been suspended and this money added to that for the Indiana Chute; the total would have been sufficient to complete the work remaining to be done under the approved project therefor. This of course would not have

decreased the cost further than to avoid the outlay for transfer of plant to and from the site of operations, but it would have completed and opened to navigation that portion of the system of improvements without further delay. Between the work on this chute and that at the head of the canal there is no practical line of division; the object of both improvements is to facilitate the passage of traffic over and around the same obstruction, and were appropriations worded as recommended and the application of the funds left to the discretion of the Secretary of War, sums too small to materially further progress when used separately could be combined to produce marked results upon one or the other.

Money statement.

July 1, 1894, balance unexpended	$2,662.14
Amount appropriated by act of August 17, 1894	20,000.00
	22,662.14
June 30, 1895, amount expended during fiscal year	19,512.42
July 1, 1895, balance unexpended	3,149.72
July 1, 1895, outstanding liabilities	260.88
July 1, 1895, balance available	2,888.84
Amount (estimated) required for completion of existing project	37,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	37,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

E E 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

The project for operations connected with this canal during the fiscal year ending June 30, 1895, contained the following items:

Regular force	$40,300
Extra labor	6,000
General repairs	6,000
Miscellaneous, fuel, oil, etc	7,000
New guard gates, new locks	8,000
Retaining wall near dry dock	10,000
North canal wall	10,000
Pavement above locks	7,000
Sodding slopes	2,000
New lock houses	12,000
Excavating channel below locks	12,000
Hydraulic dredge	20,000
Contingencies	6,000
Total	146,300

The first four items provide for regular employees for operating the locks, the towboat and dredge crews, the shop employees, and the ordinary miscellaneous repairs and supplies necessary for their maintenance. The remaining items are for special work of a more definite character necessary for maintaining the canal in good condition, but not necessarily connected with the daily operations of the regular force.

ORDINARY DAILY OPERATIONS.

The canal was open to navigation throughout the entire year, with the exception of fifteen days when the locks could not be operated on account of high water, and twenty days on account of ice, or thirty-five days in all.

The following tabular statements of traffic and commerce exhibit the traffic through the canal during the fiscal year ending June 30, 1895, as well as that passing this point by the open river or Indiana Chute during this same period:

COMMERCIAL STATISTICS.

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1895.

Vessels.	Number.	Capacity.
		Tons.
Passenger boats	622	196,072
Towboats	536	64,320
Government boats	400	30,852
Coal boats and barges	2,124	593,127
Small craft	273	45
Total	3,955	884,416

Lockages, 1,847.

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1895.

Articles.	Tons.	Articles.	Tons.
Coal	569,920½	Steel rails	31,078
Salt	5,100½	Iron, manufactured	
Oil	1,128	Produce	3,354½
Whisky	429½	Flour	376½
Tobacco	2,679	Sugar and molasses	6,571
Cotton	6,771½	Hay and straw	5,840½
Lumber	11,104½	Live stock	4,559½
Corn	1,657	Cement	1,245
Wheat	5,204½	Staves and shingles	18,489½
Miscellaneous	53,617		
Iron ore	1,535	Total	730,656

Number of passengers, 19,729.

Statement of commerce passing the Falls of the Ohio River, via Louisville and Portland Canal and Indiana Chute, from June 30, 1886, to June 30, 1895.

Articles.	From 1886 to 1894.	From 1894 to 1895.	Total for nine years.
	Tons.	*Tons.*	*Tons.*
Coal	12,503,052	951,934½	13,454,986½
Salt	84,443	6,665½	91,108½
Oil	51,737	1,349	53,086
Whisky	17,414	519½	17,933½
Tobacco	68,504	2,983	71,487
Cotton	83,005	7,527½	90,532½
Lumber	2,929,168	12,144½	2,941,312½
Corn and wheat	87,426	7,107½	94,533½
Iron ore	274,506	1,548	276,054
Iron	132,005		132,005
Steel rails	303,223	33,073	336,296
Produce	55,760	3,478½	59,238½
Hay and straw	140,797	6,387½	147,184½
Flour	11,570	491½	12,061½
Stock	61,581	5,131½	66,712½
Sugar and molasses	65,711	9,690	75,401
Staves and shingles	312,618	20,161½	334,451½
Cement	22,644	1,409	24,053
Miscellaneous	639,937	65,881	705,818
Total	17,845,101	1,137,482	18,982,583

Annual average during past nine years, 2,109,176 tons.

Statement of vessels passing Falls of the Ohio River, via Louisville and Portland Canal and Indiana Chute, June 30, 1881, to June 30, 1895.

Kinds of vessels.	1881-1894.		1895.		Total for fourteen years.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.
Passenger boats	13,786	5,565,476	725	254,906	14,511	5,820,38
Towboats	15,212	1,987,764	784	114,336	15,996	2,102,1
Government boats	1,890	145,472	403	31,122	2,293	176,5
Coal boats and barges	55,238	17,880,230	2,710	798,972	57,948	18,679,2
Small craft	2,911	137	273	45	3,184	1
Rafts	64	281	2	810	66	1,0
Total	89,101	25,579,360	4,897	1,200,141	93,998	26,779,5

Annual average during past fourteen years: Boats, 6,714+; tons, 1,912,825+.

The towboat and dredges were engaged in keeping the canal free from mud, drift, and other obstructions brought into the canal by high water; also in removing blasted rock from the channel below the locks. The total amounts of each is as follows:

	Cubic yards.
Mud removed from canal	80,250
Rock removed from channel below locks	3,850
Dirt removed from slopes	2,850
Rock on barges for north canal wall	2,920

The shop employees were continually employed making necessary repairs to the towboat, dredges, barges, mud scows, drill boat, lock machinery and other work required to keep the plant in good condition.

EXTRA LABOR.

Work under this head comprised the construction of a retaining wall and a roadway from the bridge across the old locks to the Eighteenth Street Bridge, and building a wire fence commencing at the bridge over the new locks and running westwardly on the canal property line to the property occupied by the Marion County Distillery Company. The grounds occupied by the shops and office were also inclosed by a wire fence.

The wooden fence about the office and residence was reconstructed and the shop buildings and bridge tender's cottage at Eighteenth street were repainted.

The hedge on the south side of the canal was trimmed and the slopes cleared of all trees and undergrowth that would obstruct the view of pilots.

GENERAL REPAIRS.

The old wooden timbers under the lock engines were replaced with neat iron bed castings. The old worn-out mud drums on the towboat were replaced with new ones and new brass packing rings were placed in her main cylinders.

The two double-hopper mud scows were docked and thoroughly repaired and the dredges provided with new spuds and dipper handles as often as new ones became necessary.

MISCELLANEOUS, FUEL, OIL, ETC.

The expenditures under this head were for coal, oil, cleaning material, packing, fittings, and such other supplies as were from time to time found necessary for minor repairs, etc.

NEW GUARD GATES, NEW LOCKS.

The yellow pine lumber, iron, and other material for these gates was purchased under ten-day proposals. The work of framing has been completed and the timbers are now ready for assembling, which will be done in the yard adjoining the dry dock, whence they will be launched, towed to the lock and placed in position with as little delay as possible.

RETAINING WALL NEAR DRY DOCK.

The object of this wall is to support the roadway near the dry dock and prevent its slopes from encroaching upon the space necessary for building gates, barges, and doing other work connected with the canal. It consists of a main and a wing wall, as shown in the accompanying photographs.*

Incidentally it is used to carry a narrow-gauge railroad track from the shop grounds to the dry dock and shipyard and also to carry a flight of steps down the canal slope. In connection with the construction of this wall a dry dock wall has been built with a top reference the same as the new wall, separating the dry dock and canal basin. This wall carries the railroad track already mentioned and a 4-inch main connected with the city water supply. Hydrants are located at convenient intervals from which water may be had to scour out the dry dock and wash the walls after high water.

The most important feature of this work, so far as difficulty of construction is concerned, was the crossing of the old tunnel which drains the dry dock. This tunnel was built of brick resting upon the limestone, into which the passage had been channeled to a depth of nearly 2 feet. The width of the tunnel was about 4 feet and its height 5 feet. Its axis makes an angle with the wall of about 49 degrees; the wall at this point is about 10 feet thick. The original line of the tunnel on the east side was preserved; on the west side it was made perpendicular to the face of the wall. This gave an opening 10 feet wide, in which three wickets 3 by 3 feet were placed. To sustain the wall at this point three 9-inch I beams of 30 pounds were placed; the space between the beams was filled with concrete and on the beams a monolith of limestone 2 feet 6 inches by 2 feet 7 inches by 11 feet 9 inches was placed. Back of the I beams a concrete arch with strengthening irons buried in the concrete was built, of such form as to connect by a smooth, even surface the rectangular opening with the arch of the tunnel. From the top of the arch a manhole 18 by 18 inches with iron steps at intervals of 16 inches is constructed.

The wickets are supported by two oak timbers, one bolted to the front I-beam and the other to the rock, which was channeled out to receive it. The capacity of these wickets is such as to admit of considerable enlargement of the tunnel if it is ever desired.

The dry dock terminates at the mouth of the tunnel by a wall 6.3 feet high extending entirely across the space between the two dry-dock walls. Midway of the length of this wall is a flight of stone steps leading out of the dock to the slope next to be described.

Rising from the cross wall just referred to at a slope of one-eighth a paved area was prepared for the general construction work required on the canal in building gates, barges, etc.

It is proposed to arrange for another permanent derrick upon the top of the retaining wall, by which material can be handled directly from the road on the upper grounds to the shipyard below, if this is desired.

* Not printed.

The accompanying photographs* show the stage of completion on June 25, 1895.

The work accomplished at this point to date is as follows:

Earth excavation	cubic yards	13,965
Rock excavation	do	110
Masonry laid	do	1,658.5
The average cost of excavation work to date is (per cubic yard)		$0.25
The average cost of masonry to date is (per cubic yard)		5.5

NORTH CANAL WALL.

Work under this head consisted in replacing the old dry-rubble wall with ashlar stone laid in cement mortar. The old wall was built many years ago and had become so unstable that rock from it frequently fell into the canal, making navigation dangerous.

The following amount of work was done during the year:

	Cubic yards
Rock removed	2,786.9
Loose material removed	216.5
New wall built	1,670.5

Average cost per cubic yard of wall in place, $5.20.

The price per cubic yard includes the removal of old wall, excavation, back filling, and cost of material.

PAVEMENT ABOVE LOCKS.

This pavement, built of vitrified brick, is on the north side of the canal, extending from the new locks to the dry dock over the berm between the new north wall and foot of the slope. A part of the pavement forming the "shipyard," where scows, gates, etc., may be built, was laid in mortar. The material was purchased under ten-day proposals; the grading was done by hired labor.

The quantity laid was as follows:

	Square yards
Laid in sand	1,925.5
Laid in mortar	1,157.5
Total	3,082.0

costing $6,484, or an average of $2.10 per square yard, including excavation and grading.

SODDING SLOPES.

The grading for this work was done by hired labor and the sod furnished and placed on the slope under an accepted proposal, after ten days' notice. The total number of square yards sodded was 10,773, at a cost of $2,191.01, or 20⅓ cents per square yard, which cost includes grading and preparing the slopes.

NEW LOCK HOUSES.

The old and dilapidated wooden engine houses were replaced by six new ones, built of Cloverport sandstone under a formal written contract dated September 26, 1894. A general idea of the character of these houses may be had by reference to the accompanying photographs.* The foundations were commenced October 27, 1894, and the

* Not printed.

contractor completed his work June 1, 1895. The contract price of $9,654 for all the houses does not include the cost of foundations or the rearrangement of machinery and subsequent flooring, which was done by the United States.

EXCAVATING CHANNEL BELOW LOCKS.

This work was carried on in the same manner as described in previous reports, the drilling being done by two steam drills on drill boat; the rock is broken up by dynamite and removed or displaced by the canal dredges.

During the year 8,323.8 cubic yards of rock was displaced at a cost of $6,233.86, or $0.748 per cubic yard. Of the amount displaced, 3,850 cubic yards was excavated and removed by the dredges.

HYDRAULIC DREDGE.

Various plans for a boat of this description were studied, resulting in the conclusion that the conditions are such that at present it could not be advantageously used, and the item was accordingly omitted from the estimate for 1896, submitted June 29, 1895.

DRY DOCK.

When not needed for the Government boats this dock is available for use by others at reasonable rates.

During the past year it was occupied by Government boats 80 days and 18 hours and by others 108 days and 20½ hours.

The usual statements of expenditures, collections, etc., follow:

Statement of expenditures for operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1895.

Operating and care of locks:	
Salaries of regular employees	$15,187.00
Extra labor	359.00
Repairs (labor)	102.00
Repairs (material)	862.51
Fuel and oil	1,275.79
Miscellaneous supplies, etc	1,076.74
Total	18,863.04
Operating dredges and towboats:	
Salaries of regular crews	11,668.02
Extra labor	123.94
Repairs (labor)	2,695.68
Repairs (material)	1,709.72
Fuel and oil	4,422.76
Miscellaneous supplies, etc	583.91
Total	21,204.03
Offices, general supervision, shops, etc.:	
Salaries of regular employees	13,392.67
Extra labor	5,222.72
Repairs (labor)	1,577.94
Repairs (material)	823.26
Fuel and oil	687.30
Miscellaneous supplies, etc	4,471.81
Total	26,175.70

New guard gates, new locks:	
Labor	$1,275.71
Material	4,156.84
Total	5,432.55
Retaining wall near dry dock:	
Labor	9,640.45
Material	2,539.26
Total	12,179.71
North canal wall:	
Labor	7,486.41
Material	1,203.10
Total	8,689.51
Pavement above locks:	
Labor	2,768.77
Material	3,715.23
Total	6,484.00
Sodding slopes:	
Contract	1,077.90
Labor	1,113.12
Total	2,191.02
New lock buildings:	
Contract	9,654.00
Labor	1,119.40
Material	933.46
Total	11,706.86
Excavation of channel below locks:	
Labor	2,996.97
Material	3,236.89
Total	6,233.86
Total expenditure for the year, including $8,089.17 outstanding liabilities June 30, 1895	119,160.28

During the year the following collections have been made and deposited to the credit of the Treasurer of the United States:

For rent of land pertaining to the Louisville and Portland Canal	$285.00
For use of Louisville and Portland Canal dry dock by private parties	1,136.67
Total	1,421.67

Abstract of proposals for building new lock houses, received in response to advertisement dated August 6, 1894, and opened September 6, 1894, by Capt. J. G. Warren, Corps of Engineers.

No.	Name and address of bidder.	For the two main lock buildings as specified.	For the two main lock buildings and the four small ones as specified.	Time under first proposition.		Time under second proposition.	
				For completion.	For erection.	For completion.	For erection.
				Days.	*Days.*	*Days.*	*Days.*
1	Charles L. Cornwell, Louisville, Ky.	*$7,075.00 †7,200.00	*$9,500.00 †9,700.00	‡90 to 120	‡45	130	55
2	Peter & Melcher Steam Stone Works, Louisville, Ky.	§11,933.00	§15,238.00	120	90	170	155
3	Blatz & Krebs Stone Co., Louisville, Ky.	‖8,765.65	‖11,306.85	50	30	80	50
4	Salem-Bedford Stone Co., Louisville, Ky.	¶9,293.33	¶12,241.65	‡75	‡35	‡85	‡45
5	John Diebold & Sons, Louisville, Ky.	‖9,227.73	‖11,727.73	90	45	110	60

* Cloverport stone.
† Rock Island stone.
‡ Working days.
§ Bedford stone.
‖ Norton Stone Company's quarry.
¶ Salem, Ind., quarry.

Bid of Charles L. Cornwell for constructing all the buildings of Cloverport stone accepted. Supplemental articles of agreement provide for widening the engine house, at the lower lock gates, south side, 2 feet, at an additional cost of $154.

E E 4.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

When the improvement of this river was first undertaken by the General Government the project embraced the entire reach from its mouth to La Fayette, Ind. This project, submitted by Maj. G. Weitzel, Corps of Engineers, January 4, 1872, has never been amended or revised, notwithstanding the fact that the act of March 3, 1881, separated the river into two sections, with Vincennes, Ind., as the dividing point, and that since that date specific appropriations have been made for each section.

The general project gives no specific channel width or depth, but from the various detailed projects for expenditure, it appears that for the river below Vincennes a navigable channel 3½ or 4 feet deep was to be obtained, while above that point a similar channel 3 feet in depth is desired. In this connection the following summary of the original project is given here to exhibit the nature and scope of the work then contemplated:

ORIGINAL PROJECT.

Little Chain:		
Snags and dredging	$3,000.00	
Excavating 47,371.24 cubic yards earth, at 25 cents	11,842.81	
Excavating 96,166.1 cubic yards earth, at 50 cents	48,083.05	
		$62,925.86
Grand Chain, 22,837.36 cubic yards rock excavation, at $1.25		28,546.70
Warwicks Ripple, 8,640 cubic yards excavation, at 30 cents		2,592.00
Towheads below New Harmony, Ind., 2,963 cubic yards excavation, at 75 cents		2,222.25
New Harmony Cut-off:		
4 acres of land, at $25 per acre	100.00	
8,546½ cubic yards dam, at 75 cents per cubic yard	6,342.25	
		6,442.25

Coffee Island Chute:		
11,072.4928 cubic yards rock excavation, at $1.25	$13,840.62	
343 cubic yards riprap, at $2 per cubic yard	686.00	
		$14,526.62
White River Shoals, 3,120.824 cubic yards rock excavation, at $1.25 per cubic yard		3,901.03
Grand Rapids:		
917.88 cubic yards of excavation for foundation, at $1.50 per yard	1,376.32	
1,261.40125 cubic yards of foundation, at $8 per yard	10,091.21	
8,000 cubic yards of wall masonry, at $10 yer yard	80,000.00	
2 sets gates, with machinery	15,000.00	
Removing old locks	3,532.48	
Repairing dam	25,000.00	
		135,000.01
Little Rock		500.00
Nine Mile Ripple, 3,700 cubic yards loose stone, at 75 cents		2,775.00
Horse Shoe Bend, sand and gravel bar, 3,703 yards, at $1.25		4,629.12
Swan Island, 4,629 cubic yards excavation, at $1.25		5,787.50
Dredging and snagging		14,400.00
		284,247.88
Add 10 per cent for superintendence and contingencies		28,424.78
Total		312,672.66

Of these items, "Horse Shoe Bend" and "Swan Island" are above; the others, excepting "dredging" and "snagging," applicable to the whole river, below Vincennes, Ind.

This résumé is presented to explain the apparent discrepancy in the original estimates and the present condition of the work, and the necessity for their revision, so as to provide for a navigable channel of specified width and depth suitable for the navigable interests of the river.

In reviewing the work done under this project it is found that the work of snagging was commenced at the mouth of the river and continued at "Little Chain," "towheads below New Harmony," and at other points not mentioned therein.

The closing of the "cut-off" at New Harmony by a dam proved a most tedious, troublesome, and expensive operation on account of the unstable nature of the ground at the end of the dam; it was finally completed at a cost several times greater than the original estimate.

The cost of the work at Warwicks Ripple was also far in excess of the estimate therefor; and such has been the case with all the other items in the project, whether the work was done by contract or by hired labor, and has been caused not alone by engineering difficulties which it was impossible to foresee and provide for, but also by irregular and insufficient appropriations to push the work to completion at once.

At Grand Rapids the original estimate was based upon the use of certain parts of the old structures there which were to be incorporated with the new ones. This was found impracticable when the actual construction was made, and for this reason more material had to be purchased and the estimated amount of excavation was increased.

Since 1884 the greater part of the appropriations for "below Vincennes" has been applied to the construction of the lock and dam at Grand Rapids; this being regarded as the most important work on the river. During these years the other works have deteriorated, some have been utterly destroyed, and others form worse obstructions to navigation than those which they are intended to remove. The lock and dam are practically completed, open to navigation, but excepting at high stages of water the remainder of the river is no longer navigable to boats of any size, and even at these high stages far from safe.

In 1886 the officer then in charge of the work estimated that $160,000 would be acquired to accomplish necessary work on the river below Vincennes. This figure can not, in my judgment, be decreased.

It is respectfully recommended that future appropriations be made applicable to "improving the Wabash River, Indiana and Illinois;" the appropriations for the river above Vincennes have barely sufficed to keep it free from snags, and no benefit can be had from work done there until the lower part of the stream is cleared of obstructions.

The operations on the the two sections of the river during the fiscal year ending June 30, 1895, were as described below:

IMPROVEMENT BELOW VINCENNES.

The work of completing the dam at Grand Rapids was commenced as soon as the appropriation of August 17, 1894, became available. An immense quantity of drift had accumulated on the dam and a portion of the sheeting had been torn away by the ice of the previous winter; this was regained, and, together with the bevel sticks of the lower course, replaced in the dam, and all cribs filled with stone and sheeted, except 25 spaces of 3 feet each on the lower course, previous to high water. These spaces, together with a portion of the dam torn out during January, 1895, have been completed, and all that remains to be done is the gravel filling on the upstream side of the dam. The lock has been available for use during the entire year, but until the river below is radically improved it is not likely to be extensively used. The guiding dikes for the lock have been designed, and it was hoped that the funds now on hand would be sufficient to permit their construction, but upon opening bids for furnishing the lumber and other material it was found that their construction would have to be deferred. In the meantime it is proposed to prepare as much of the foundation for them as may be practicable. It is estimated that the proposed structures at the lock will cost, approximately, $12,000.

The accompanying illustrations* show the character of the work now so nearly completed at Grand Rapids.

The following is a summary of all appropriations that have been applicable to work below Vincennes, Ind.:

By the act—		By the act—	
Approved June 10, 1872.....	$50,000	Approved August 2, 1882....	$40,000
Approved March 3, 1873.....	50,000	Approved July 5, 1884.....	30,000
Approved June 23, 1874.....	25,000	Approved August 5, 1886....	60,000
Approved March 3, 1875.....	40,000	Of August 11, 1888.....	60,000
Approved August 14, 1876...	70,000	Approved September 19, 1890	60,000
Approved June 18, 1878.....	50,000	Approved July 13, 1892.....	60,000
Approved March 3, 1879.....	20,000	Of August 17, 1894.....	15,000
Approved June 14, 1880.....	25,000		
Approved March 3, 1881.....	25,000	Total	680,000

Of the total amount appropriated to March 3, 1881, when the river was divided into two sections, $317,845.44 had been expended for improvements and $7,000 for the purchase of rights and titles of the Wabash Navigation Company. Since that date the sum of $325,000 has been appropriated, of which, and the balance on hand March 31, 1881, $25,000 has been applied to improvements at or in the vicinity of Grayville, Ill., and $325,060.36 expended in the construction of the lock and dam at Grand Rapids, snagging, and other general work.

* Not printed

The total expenditures to June 30, 1895, for all works below Vincennes is $674,905, including outstanding liabilities on that date.

Money statement.

July 1, 1894, balance unexpended	$309.60
Amount appropriated by act of August 17, 1894	15,000.00
	15,309.60
June 30, 1895, amount expended during fiscal year	8,690.34
July 1, 1895, balance unexpended	6,619.26
July 1, 1895, outstanding liabilities	1,525.06
July 1, 1895, balance available	5,094.20
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

IMPROVEMENTS ABOVE VINCENNES.

Being engaged at other work, the snag boat *Osseo* has been unable to reach this portion of the river where snagging was the principal work contemplated. No work has been done since last report.

The estimates, project, condition of river, etc., are hereinbefore referred to and need not be repeated here.

The following is a summary of all appropriations made for the work to date:

By the act—		By the act—	
Approved March 3, 1881	$25,000	Approved July 13, 1892	$5,000
Approved August 2, 1882	30,000	Of August 17, 1894	5,000
Approved July 5, 1884	10,000	Total	85,500
Of August 11, 1888	5,000		
Approved September 19, 1890	5,500		

The total expenditures to date for this portion of the river amount to $81,593.56, including outstanding liabilities.

Letters requesting information concerning the traffic and commerce on this river during the past year were addressed to all parties supposed to to have such records, but no satisfactory replies were received, and but two steamboats, the *May Belle* and the *Peankishaw*, have passed the locks; all other lockages were house boats or skiffs, not engaged in river traffic.

Money statement.

July 1, 1894, balance unexpended	$550.48
Amount appropriated by act of August 17, 1894	5,000.00
	5,550.48
June 30, 1895, amount expended during fiscal year	1,637.19
July 1, 1895, balance unexpended	3,913.29
July 1, 1895, outstanding liabilities	6.85
July 1, 1895, balance available	3,906.44
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

E E 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The improvement of this river was commenced in 1879. At that time it was badly obstructed by snags, rocks, shoal places, and rock reefs. The adopted project provides for the removal of snags, concentration of water flow by wing dams and excavation of channels where necessary, so as to make the river navigable for light-draft boats. Work has been confined to the lower portion of the river, principally between its mouth and Hazleton, Ind., 17 miles above.

The original project of May 14, 1879, contemplated improvements over the reach of river from its mouth through a distance of about 40 miles, to Petersburg, Ind., thence up each branch as far as might be practicable without locks and dams, in all a distance of about 75 or 80 miles, the estimated cost of which was as follows:

Improving Kellys Ripple	$20,000
Rock excavation at other ripples and shallow places	25,000
Removing bar, snags, and piers of old aqueduct	5,000
Confining channel for removal of bars and protection of banks	50,000
Removing snags	37,500
Engineering and contingent expenses	12,500
Total	150,000

This estimate was based on information gained from a hasty survey or reconnoissance made at the rate of 8 or 10 miles a day. In his report of December 27, 1878, concerning this survey, the officer then in charge says with reference to snags in the West Fork: "In my estimation $1,000 a mile would, in most places, be considered a small estimate." In the lower river the obstruction at Kellys Ripple was considered the worst, and from information based on a more reliable survey the estimated cost of this work was increased in 1880 to $25,000.

The work at this point has proven to be the most permanent of any upon the river, since during more recent years the appropriations have been too small to permit other than snagging work to be done, and such brush dams as had been built to close cut-offs and concentrate the water flow have become rotten and carried away by ice and high water, leaving the navigable condition of the river, at present, in a very unsatisfactory condition.

The snag boat *Osseo* was at work from July 1 to August 4, 1894, on a portion of the river known as Seven Mile Bend. During this period of operations 195 snags with an aggregate weight of 726.8 tons were removed from the river. The appropriation of August 17, 1894, provides for a resurvey of this river, which has never been accurately surveyed except for a distance of 12 or 13 miles above its mouth. This it has not yet been found practicable to do, but at the first favorable opportunity it is intended to place a party in the field and make the survey during the most propitious season when the natural conditions are most advantageous. When this has been done a reliable estimate can be made of what is at present necessary for the improvement of this river.

The following is a summary of all appropriations made for the work up to June 30, 1895:

By the act—		By the act—	
Approved March 3, 1879	$25,000	Of August 11, 1888	$5,000
Approved June 14, 1880	20,000	Approved July 13, 1892	5,000
Approved March 3, 1881	20,000	Of August 17, 1894	5,600
Approved August 2, 1882	20,000		
Approved July 5, 1884	10,000	Total	117,500
Approved August 5, 1886	7,500		

The total of expenditures for this work to date is $112,669.55, of which $3,151.87 was expended during the past fiscal year.

No satisfactory data concerning the traffic and commerce on this river could be obtained, notwithstanding that letters requesting such information were addressed to all parties supposed to have records of it.

Money statement.

July 1, 1894, balance unexpended	$2,982.32
Amount appropriated by act of August 17, 1894	5,000.00
	7,982.32
June 30, 1895, amount expended during fiscal year	3,151.87
July 1, 1895, balance unexpended	4,830.45
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	2,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

APPENDIX F F.

IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA, AND OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, COL. (NOW BRIG. GEN.) WM. P. CRAIGHILL AND LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on Great Kanawha River, West Virginia.
3. Elk River, West Virginia.
4. Gauley River, West Virginia.
5. New River, Virginia and West Virginia.

EXAMINATIONS.

6. Big Coal and Little Coal rivers, West Virginia.
7. Elk River, West Virginia.

(For letter of transmittal see Appendix H.)

F F 1.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles. The means are locks and dams. The locks are about 300 by 50 feet, above Charleston, and about 340 by 55 feet below. The following table shows the present condition:

No.	Distance from Charleston.	Style of dam.	Completed in—	Remarks.
2	26 miles above	Fixed	1887	In operation.
3	21 miles above	do	1882	Do.
4	15 miles above	Movable	1880	Do.
5	9 miles above	do	1890	Do.
6	4 miles below	do	1886	Do.
7	14 miles below	do	1893	Do.
8	22½ miles below	do	1893	Do.
9	32 miles below	do		Under contract for completion.
10	39½ miles below	do		Do.
11	56½ miles below	do		Do.

Dredging is also necessary in some of the pools, as well as the occasional removal of snags and rocks. It is expected the improvement will be completed in 1896.

Mr. A. M. Scott has continued to exercise the local charge in his usual efficient manner. His report, which is appended, treats in detail of the operations of the year.

As the improvement of the river has progressed the commerce on it, notably the shipment of coal, has greatly increased.

The telephone line has been maintained between the central office in Charleston and the locks, and it is used by night as well as by day, being found indispensable for the proper oversight and direction of the operations, as well of construction and of maintenance.

A gauge reader has been kept at Kanawha Falls, near which place the Gauley joins the New to form the Great Kanawha River, and another at Hinton, where the Greenbrier empties into the New River. The compensation of these men is less than $10 a month each. They send to the central office daily reports by postal card of the stage of the river at their respective stations and by telegraph when there is a rapid rise. These reports are necessary as warnings to the central office in Charleston in order that such maneuvers of dams, etc., may be had in time as the height and duration of the freshet may require.

The appropriation, March 2, 1895, of $580,700 completes the amount estimated for the existing project. The finished works are maintained with funds from the general appropriation of July 5, 1884, for operating and care of canals and other works of navigation.

The following are the amounts and dates of appropriations for improving Great Kanawha River, West Virginia:

March 3, 1873	$25,000	July 5, 1884	$200,000
June 23, 1874	25,000	August 5, 1886	187,500
March 3, 1875	300,000	August 11, 1888	350,000
August 14, 1876	270,000	September 19, 1890	300,000
June 18, 1878	222,000	July 13, 1892	225,000
March 3, 1879	150,000	March 3, 1893	500,000
June 14, 1880	200,000	March 2, 1895	580,700
March 3, 1881	200,000		
August 2, 1882	200,000	Total	3,935,200

Money statement.

July 1, 1894, balance unexpended		$476,626.71
Amount appropriated by sundry civil act approved March 2, 1895		580,700.00
		1,057,326.71
June 30, 1895, amount expended during fiscal year		273,270.85
July 1, 1895, balance unexpended		784,055.86
July 1, 1895, outstanding liabilities	$4,000.00	
July 1, 1895, amount covered by uncompleted contracts	640,301.86	
		644,301.86
July 1, 1895, balance available		139,754.00

Abstract of proposals for ironwork for Dams Nos. 9, 10, and 11, Great Kanawha River, West Virginia, opened at U. S. Engineer Office, Charleston, W. Va., at 2.35 p. m. September 27, 1894.

No.	Name and address of bidder.	Wrought iron (approximate quantity, 586,000 pounds).		Driftbolts (approximate quantity, 49,000 pounds).		Cast iron (approximate quantity, 337,000 pounds).		Total amount.
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.	
1	Russell Wheel and Foundry Co., Detroit, Mich	*Cents.* 5.59	$32,757.40	*Cents.* 1.79	$877.10	*Cents.* 1.90	$6,403.00	$40,037.50
2	The J. & E. Greenwald Co., Cincinnati, Ohio	6	35,160.00	2.36	1,156.40	3	10,110.00	46,426.40
3	Ryan, McDonald Manufacturing Co., Baltimore, Md	4.57	26,780.20	2.08	1,019.20	2.33	7,852.10	35,651.50
4	The Phœnix Bridge Co., Philadelphia, Pa	5.75	33,695.00	4	1,960.00	3.80	12,806.00	48,461,00
5	James Rees & Sons, Pittsburg, Pa	5.10	29,886.00	2.20	1,078.00	2.80	9,436.00	40,400.00
6	The Hoefinghoff & Lane Foundry Co., Cincinnati, Ohio	6.25	36,625.00	2.33½	1,143.33	2.25	7,582.50	45,350.83
7	Brown-Ketcham Iron Work, Indianapolis, Ind	5.46	31,995.60	2.45	1,200.50	2.48	8,357.60	41,553.70
8	Lane Bros. Bridge and Construction Co., Newark, Ohio	4.70	27,542.00	1.95	955.50	2.09	7,043.30	35,540.80
9	William H. March, Philadelphia, Pa	4.47	26,194.20	1.84	901.60	2.73	9,200.10	36,295.90
10	The Snead & Co. Iron Works, Louisville, Ky	5.64	33,050.40	2.71	1,327.90	2.23	7,515.10	41,893.40
11	The Van Dorn Iron Works Co., Cleveland, Ohio	4.90	28,714.00	1.90	931.00	2.90	9,778.00	39,418.00
12	The Youngstown Bridge Co., Youngstown, Ohio	4.09	23,967.40	2.10	1,029.00	2.10	7,077.00	32,073.40
13	The Fred J. Myers Manufacturing Co., Hamilton, Ohio	6.10	35,746.00	5.90	2,891.00	2.33½	7,863.33	46,500.33
14	The Novelty Iron Co., Canton, Ohio	4.75	27,835.00	1.83	896.70	1.93	6,504.10	35,235.80

Contract awarded to the Youngstown Bridge Company.

Abstract of proposals for building five frame houses for lock hands, at Locks Nos. 7 and 8, Great Kanawha River, W. Va., opened at U. S. Engineer Office, Charleston, W. Va., at 2.40 p. m. May 31, 1895.

Kind of work and material.	Approximate quantity.	(1) Morgan & Gardner, Charleston, W. Va.		(2) Stark & De Bord, Charleston, W. Va.		(3) Gilliland & Wildman, Charleston, W. Va.	
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
Lock No. 7:							
Two houses, etc		$1,999.98	$1,999.98	$1,548.76	$1,548.76	$1,486.00	$1,486.00
Masonry... cubic yards	28	3.80	106.40	6.00	168.00	4.40	123.20
Excavation ...do	86	.25	21.50	.25	21.50	.30	25.80
Pier stone ...number	20	1.65	33.00	1.50	30.00	2.00	40.00
Lock No. 8:							
Three houses, etc		2,999.97	2,999.97	2,323.14	2,323.14	2,229 00	2,229.00
Masonry...cubic yards	52	3.80	197.60	6.00	312.00	4.40	228.80
Excavation ...do	129	.25	32.25	.25	32.25	.30	38.70
Pier stone ...number	30	1.65	49.50	1.50	45.00	2.00	60.00
Total			5,440.20		4,480.65		4,231.50

Kind of work and material.	Approximate quantity.	(4) James M. Mays, Charleston, W. Va.		(5) David Eagan, Charleston, W. Va.		(6) Henry Crawford, St. Albans, W. Va.	
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
Lock No. 7:							
Two houses, etc		$2,130.00	$2,130.00	$1,275.00	$1,275.00	$1,520.00	$1,520.00
Masonry...cubic yards	28	5.50	154.00	3.75	105.00	5.00	140.00
Excavation ...do	86	.35	30.10	.25	21.50	.25	21.50
Pier stone ...number	20	1.30	26.00	1.00	20.00	1.00	20.00
Lock No. 8:							
Three houses, etc		3,170.00	3,170.00	1,977.00	1,977.00	2,280.00	2,280.00
Masonry...cubic yards	52	5.75	299.00	3.75	195.00	5.00	260.00
Excavation ...do	129	.35	45.15	.25	32.25	.25	32.25
Pier stone ...number	30	1.35	40.50	1.00	30.00	1.00	30.00
Total			5,894.75		3,655.75		4,303.75

Contract awarded to David Eagan.

REPORT OF MR. ADDISON M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 3, 1895.

COLONEL: I have the honor to submit the following report on the Great Kanawha River improvement for the year ending June 30, 1895:

The principal work during the year has been on the construction of Locks Nos. 9, 10, and 11, and in maintaining and operating the seven completed locks and dams.

The principal work on construction will be given first.

LOCK AND DAM NO. 9—CONTRACT FOR FOUNDATIONS AND MASONRY.

[Movable dam, 25 miles from mouth of river and 33 below Charleston.]

Work on this contract has been mainly directed to building masonry for the lock inside the cofferdam, and at quarrying and cutting stone for the lock and for the foundations of the dam. Fair progress was made during the year.

It was on the whole a good year for river work. Work inside the cofferdam at No. 9—mainly excavating for the lock foundations and laying masonry—was in progress last season after July 1 without interruption until November 20, when masonry was stopped for freezing weather. Work on the guard cribs and at paving the slope above the lock was continued when the weather permitted until December 25, when operations were suspended for winter.

The cofferdam pumps were started this spring on April 27. The water was out so that excavation inside the coffer—cleaning the walls, ditches, etc., of winter deposit of mud—was begun April 29. Laying masonry was resumed May 13 and was just getting under way when the cofferdam was flooded by a rise in the river May 17. The water fell so that pumping was resumed May 20. Masonry was resumed on the 23d, and work inside the cofferdam has gone on uninterruptedly since that date.

The following are the quantities of finished work done on this contract during the year:

Backing masonry	cubic yards	3,931
Rock-face masonry	do	1,127
Pointed-face masonry	do	1,227
Cut-stone masonry	do	242
Sills masonry	do	242
Quoins masonry	do	50
Coping masonry	do	37
Concrete	do	120
Paving	do	87
Stone filling	do	1,176
Timber in permanent construction	feet, B. M.	55,128
Sheathing	do	4,200
Bolt holes in masonry	linear feet	492
Puddling	cubic yards	166
Embankment	do	2,828
Excavation, earth, etc	do	6,881
Excavation, rock	do	103

Present condition.—The lock is well advanced. There are still to be set on the lock about 1,590 cubic yards of masonry. With the exception of a small part of two courses, the land wall, including wings, is complete to bottom of coping, and 100 feet of the coping is set. The river wall is finished five courses—10 feet in height—from top of miter-sill level, and about one-third of the sixth course is set. The miter sills are completed except the cushion sticks and anchorage; the drilling for the anchorage is done. The lower guard crib lacks one round of timber and the upper one five rounds of being finished. The embankment and stone drain back of land wall are nearly up with the masonry. Part of the paving above and about the upper wing is in place.

It is expected the removal of the lock cofferdam and the building of the coffer for the first section of the navigation pass will be commenced during the present month. After the water is let into the cofferdam the rest of the lock masonry will be set by derrick boats.

A general description of Lock and Dam No. 9 is given in the Annual Report of the Chief of Engineers for 1893, page 2588. For further description, including that of the cofferdam for the lock, reference may be made to pages 1954–1955 of the Report for 1894.

LOCK AND DAM NO. 10.—CONTRACT FOR FOUNDATIONS AND MASONRY.

[Movable dam, 19 miles from mouth of river and 38 below Charleston.]

Work on this contract was mainly directed to preparing foundations for and laying masonry inside the cofferdam for the lock, and at preparing stone for the lock and dam. The contractors, Zimmerman, Truax & Sheridan, who have also the contract for No. 9, made slow progress on No. 10 during the year. They appear unable to carry on both works to good advantage. They have been making more headway latterly, however, and better progress from this time on is hoped for.

Work on the foundations of the lock, as generally noted above, was in progress last season, generally with a small force, until November 20, when the laying of masonry was stopped on account of freezing weather. The cofferdam was filled through the sluices December 14, and operations practically suspended for winter.

The pumps were started this spring, May 2. Excavation inside the cofferdam—cleaning the works of winter deposit—began May 4. The laying of masonry was resumed May 13, but was stopped on the 17th by the rise in the river, referred to under the head of Lock 9. The pumps were started again May 20. Masonry was resumed on the 23d and work inside the cofferdam has been in progress since that date.

The following are the quantities of finished work done on the contract during the year:

Backing masonry	cubic yards..	2,891
Rock-face masonry	do....	821
Pointed-face masonry	do....	1,025
Cut-stone masonry	do....	158
Sills	do....	139
Quoins	do....	97
Concrete	do....	32
Stone filling	do....	436
Sheathing	feet, B. M..	4,300
Bolt holes in masonry	linear feet..	200
Puddling	cubic yards..	218
Embankment	do....	2,170
Excavation, earth, etc	do....	6,235
Excavation, rock	do....	92

Present condition.—There are still about 2,720 cubic yards of masonry to lay on the lock. The land wall, except lower wing, is nearly completed to the top of the fifth course—10 feet in height—above miter sill. The sixth and seventh courses are about three-fourths set, and a beginning has been made on the eighth and ninth courses. (The tenth course is the coping.) The upper wing is up to bottom of coping, but nothing has been done yet, except at excavation, on the lower wing. The puddling is all in about the upper wing, and the embankment and stone drain back of the land wall is mostly up with the masonry.

The river wall has the third course above miter-sill level completed; the fourth course is nearly finished, and about one-third of the fifth course is set. The upper miter and cross-sills are finished except the placing of the cushion sticks and anchorage, and a part of the foundation course for the lower sill is in place.

A general description of Lock and Dam No. 10 is given on page 2588 of the Annual Report of the Chief of Engineers for 1893. For further description, including the cofferdam for the lock, reference may be made to page 1955 of the Report for 1894.

LOCK AND DAM NO. 11—CONTRACT FOR FOUNDATIONS AND MASONRY.

[Movable dam, 1⅛ miles from mouth of river and 83⅛ miles below head of slack water.]

Work on this contract during the year has been mainly directed to excavating for, and putting in concrete and masonry for the lock inside the cofferdam, and at quarrying and preparing stone for the lock and for the foundations of the dam.

The contractor, Mr. Thomas Munford, has a good plant (see Report of Chief of Engineers for 1894, p. 1956), and has employed a large force whenever practicable and has made excellent progress. The quantities of finished work done during the year are given below.

As stated in the last annual report, some difficulty was experienced in pumping out the lock cofferdam, on account of part of it not being well down to hardpan. This was overcome by driving heavy sheet piling outside next to the sheathing with a pile driver, and the water exhausted so that excavation inside the cofferdam was begun July 2. The first concrete was put in July 14 and the first stone set in the foundation on the 17th.

The excavation for foundations and transportation of materials across the river (the latter being done by the cableway) were carried on as far as practicable night and day and the work generally pushed with a good deal of energy. All of the concrete for the foundations of the lock, aggregating as shown below, 6,017 cubic yards, was placed between July 14 and October 25. The concrete plant, consisting of elevator, screen, derricks, mixer, etc., all run by steam, proved a decided success, doing the work rapidly and well. After a little practice 11 batches (each containing 2 barrels of cement, 15 cubic feet of sand, and 33 feet of broken stone), making 1¼ cubic yards of concrete rammed in place, were mixed, taken across the river (a distance to nearest part of lock foundation of about 900 feet) by cableway and put in place per hour.

Fortunately the hardpan was found everywhere at the site of the lock, about as indicated by the preliminary examinations and borings. It is a compact, indurated clay, of reddish color, free from gravel or grit. It is somewhat irregular in quality, in places being very hard and "chunky" and in others finer and rather crumbly. It was perfectly dry, no water at all coming through it, and cut down plumb and smooth on the sides of the excavations. It disintegrated on fair exposure to the sun and air. In places it was rather difficult to get the bottom smooth and in good shape to receive the concrete. A coat of "one to one" mortar was put on the hardpan, everywhere, on bottom and sides, before the concrete went on.

The hardpan was covered with sand, gravel, and earth from 10 to 19 feet deep. The elevation of the top of the hardpan varied considerably, particularly between the sites of the land and river walls, and it was necessary to extend the excavation into it from 2½ to 10 feet in order to get the foundations down to a nearly uniform level. The foundations of the bottom of the river and land walls are at tide reference 491.3′ and 492′, respectively. The elevation of low water is 510′, making the foundation 18.7 and 18 feet below that reference. The foundations of the miter sill are at 490′ or 20 feet below low-water mark.

The top of miter sills is at 504′. The top of the coping is 526′, making the walls from 34 to 34.70 feet high from hardpan. From 4 feet to 4.7 feet of concrete was put under the main walls. Concrete was also used for the interior of the walls up to within two courses (4 feet) of level of miter sills, where the regular masonry begins.

With the exception of about four days' suspension in September, caused by a rise in the Ohio, work in the cofferdam was carried on without interruption until November 20, when masonry work was stopped by cold weather. The cofferdam was filled by another raise in the Ohio December 5, when operations on the river were stopped for winter.

The cofferdam pumps were started this spring on April 29. The laying of masonry was resumed May 2, and has been in progress since. The rise of May 17 stopped work on the river wall three or four days, but the land wall was built up higher, and work on that was not suspended.

The quantities of work done on this contract during the year, not including materials prepared, were as follows:

Backing masonry	cubic yards	5,011
Rock-face masonry	do	2,848
Pointed-face masonry	do	1,752
Cut-stone masonry	do	333
Sills	do	267
Quoins	do	64
Coping	do	6
Concrete	do	6,071
Paving	do	354
Riprap	do	845
Stone filling	do	2,422
Timber in permanent construction	feet B. M.	70,000
Sheathing	do	31,600
Bolt holes in masonry	linear feet	420
Puddling	cubic yards	502
Embankment	do	8,136
Excavation—earth, etc	do	24,676
Excavation—hardpan	do	4,927
Excavation—rock	do	296
Crib logs in cofferdam	linear feet	17,771
Cofferdam filling	cubic yards	1,970

Present condition.—Work on the lock is well advanced. There are still about 1,250 cubic yards of masonry to set on the lock. The land wall, including the wings, is completed to bottom of coping, except a small amount on the last three courses at

the lower end. The river wall is completed to 13.83 feet above miter sills, or to within 8.17 of top of coping, and has three courses above that level about half in. The miter sills, including the cushions and anchorage, are completed and the retaining and guard cribs are nearly finished. The puddling and embankment, and drain back of the land wall are nearly completed. The paving and riprap on slopes above and below the guard cribs is partly placed.

Tearing out the cofferdam for the lock was begun with the dredges day before yesterday, July 1. The remainder of the river wall masonry will be set from derrick boats.

Dredging for and building the cofferdam for the navigation pass will be commenced in a few days; the bulkheads for the coffer connections with the lock wall have just been put in.

A general description of Lock and Dam No. 11, is given in the Annual Report of the Chief of Engineers for 1893, pages 2588 and 2589. For further description, including the lock cofferdam, etc., reference may be made to pages 1955 and 1956 of the Report for 1894.

OPERATING THE COMPLETED WORKS.

With the exception of Lock No. 3, which was under repairs five days in October, as described below, the seven completed locks and dams remained in good working order throughout the year. As usual, a good deal was done at the different locks, mainly by the regular hands, in keeping the works in order. Some of the most important items of repairs and work are mentioned below.

Lock No. 2, fixed dam.—Locking was suspended at No. 2 thirty-three days by ice and four days by high water during the year.

In addition to ordinary repairs and work about 600 cubic yards of stone was taken from the bar below the dam during low water last fall, mainly to improve the direction of the current below the lock. For the same purpose a rough crib was built between the lower end of the lock wall and a remnant of the old crib cofferdam. The stone taken from the bar was used to strengthen and repair the riprap on the abutment side below the works.

Lock No. 3, fixed dam.—Locking was suspended at No. 3 thirty-one days by ice and four and one-half days by high water. Locking was also suspended five days in October to bulkhead the forebay to refasten some of the sheaves, etc., for the chains of the filling valves that had worked loose in the masonry.

In accordance with authority given by the Chief of Engineers, the crest of this dam was raised in a temporary way 16 inches during low water in August, mainly to try the effect on the side current at the lower approach of Lock No. 2. The dam was raised by splash boards, well nailed and braced. They stood the winter floods and ice better than expected, and are still nearly all in place. This raising had a decidedly good effect at Lock No. 2, and proved the advisability of making this increase in height permanent during low water this fall. In addition to bettering the side current at No. 2 it will considerably reduce the dredging required to make 7 feet depth at Harvey Shoal and vicinity in the upper end of the pool.

The commerce through Locks Nos. 2 and 3 during the year was as follows:

		Lock No. 2.	Lock No. 3.
Coal	bushels	997,600	2,503,300
Coke	tons	4,500	4,500
Miscellaneous freight, merchandise, produce, etc., by steamboats	do	2,704	3,019
Lumber and logs	feet B. M.	180,700	298,500
Coal and coke barges	number	209	437
Steamboats	do	1,431	1,384
Other craft, house boats, etc	do	46	53
Shingles	do	.....	20,000
Brick	do	9,100	18,750
Passengers	do	5,542	6,464
Lockages made	do	1,465	1,618

Lock No. 4, movable dam.—This dam was kept up two hundred and nineteen days during the year and down the rest of the time, owing to high or sufficient stages of water, or ice.

In addition to ordinary repairs 21 shunting hurters were placed on the weir in February. This, with the 30 put in last year, replaces all of the old hurters on the weir with the improved form.

A new "drum house" to store materials belonging to the dam was built last winter; the work was done by the regular lock hands.

The maneuvers of the dam and some of the principal items of commerce at No. 4 are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		A. m.		
Lowered	Dec. 14	2 00	5	No material difficulty.
Raised	Dec. 20	8 00	6	Do.
Lowered	Dec. 29	5 00	7	Delayed considerably by ice.
Raised	May 1	8 00	6	One hour adjusting tripping bar. No material difficulty.
Lowered	May 13	1 10	6	No difficulty.
Raised	May 31	5 45	6	Do.

	Through the lock.	Through the navigation pass.	Total.
Coal, bushels	3,166,000	3,490,000	6,656,000
Coke, tons	1,000	3,500	4,500
Lumber and logs, feet, B. M.	149,250	236,500	385,750
Salt, barrels	287	160	447
Steamboats, number	1,037	744	1,781
Coal barges, do	511	632	1,143
Other craft, house boats, etc, do	16	23	39
Lockages made, do			1,178

Lock No. 5, movable dam.—This dam was kept up two hundred and eighteen days during the year and down the rest of the time owing to high or sufficient stages of water or ice.

New panels were put in all the pass wickets during the year. These wickets are now fifteen years old. The main timbers of the wickets appear pretty sound, and will probably last several years yet. On the weir the wickets were overhauled and repaired and some entirely new ones put in.

A new drum house and a blacksmith shop were built during the year, the work being done by the lock men.

The maneuvers of the dam and the commerce at No. 5 are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		A. m.		
Lowered	Dec. 14	1 20	4 to 6	No difficulty.
Raised	Dec. 18–19	13 00	5 to 6	Delayed 3 hours and 20 minutes repairing wickets.
Lowered	Dec. 29	3 35	4 to 8	No material difficulty.
Raised	May 1–2	15 50	5 to 6	Delayed 8½ hours replacing broken horse and locking.
Lowered	May 13	1 30	3 to 6	No difficulty.
Raised	May 31–June 1	22 00	6 to 7	12½ hours spent in putting new panels in pass wickets.

	Through the lock.	Through the navigation pass.	Total.
Coal, bushels	5,262,700	7,507,300	12,770,000
Coke, tons	1,000	3,500	4,500
Lumber and logs, feet, B. M.	217,617	261,850	479,467
Shingles, number	849,200	532,000	1,381,200
Brick, do	27,825	69,000	96,825
Salt, barrels	930	335	1,265
Miscellaneous freight, merchandise, produce, etc, tons	8,725	2,633	11,358
Steamboats, number	1,204	830	2,034
Coal barges, do	991	1,206	2,197
Other craft, house boats, etc, do	117	51	168
Passengers, do	19,677	3,512	23,189
Lockages made, do			1,466

Lock No. 6, movable dam.—This dam was kept up 220 days during the year.

In addition to ordinary repairs the main storehouse and the drum house were repaired and enlarged to fit them for general storehouses for supplies for all of the

finished locks. This was done by purchase of material and hired labor, assisted by the regular lock men

The maneuvers of the dam and the commerce at this lock are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Lowered	Dec. 14	2 00	5	2 wickets failed to trip. No material difficulty.
Raised	Dec. 20	7 00	5	No difficulty.
Lowered	Dec. 29	6 30	5	Lowered slowly on account of ice. No difficulty.
Raised	Apr. 29–30	15 30	3 to 6	Delayed several hours by deposit in pier recess and foul chains.
Lowered	May 13	3 00	5	Delayed 1 hour and 40 minutes by drift and 1 wicket failing to trip. No material difficulty.
Raised	May 31	10 45	4 to 5	No material difficulty.

		Through the lock.	Through the navigation pass.	Total.
Coal	bushels	4,032,000	11,746,000	15,778,000
Coke	tons	1,000	3,500	4,500
Lumber and logs	feet, B. M.	1,478,850	5,938,750	7,417,600
Staves	number	.....	890,000	890,000
Shingles	do	11,000	.....	11,000
Brick	do	156,000	.....	156,000
Salt	barrels	100	2,000	2,100
Miscellaneous freight, merchandise, produce, etc	tons	7,461	15,675	23,136
Steamboats	number	1,272	1,021	2,293
Coal barges	do	712	1,525	2,237
Other craft, house boats, etc	do	108	22	130
Passengers	do	39,111	13,705	52,816
Lockages made	do	.....	.....	1,255

Lock No. 7, movable dam.—This dam was kept up two hundred and thirteen days during the year.

The extension of No. 7 of the bank protection below the abutment, referred to in the last annual report, was continued in July. In doing this about 300 cubic yards of additional riprap was used and 150 cubic yards of earth moved in grading the bank.

The maneuvers of the dam and the commerce in this lock are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Lowered	Dec. 14	0 46	7	No difficulty.
Raised	Dec. 20	5 42	6	Do.
Lowered	Dec. 29	4 55	6	Delayed considerably by ice.
Raised	May 3	8 45	6	Delayed 2 hours, mainly by drift under wickets.
Lowered	May 13	1 35	6	No difficulty.
Raised	June 3	12 10	6	No material difficulty.

		Through the lock.	Through the navigation pass.	Total.
Coal	bushels	2,076,700	13,783,000	15,859,700
Coke	tons	.....	4,500	4,500
Lumber and logs	feet, B. M.	875,140	4,171,550	5,046,690
Railroad ties	number	549	1,000	1,549
Staves	do	.....	950,000	950,000
Shingles	do	11,000	20,000	31,000
Brick	do	6,000	.....	6,000
Salt	barrels	.....	2,000	2,000
Miscellaneous freight, merchandise, produce, etc	tons	4,648	12,945	17,593
Steamboats	number	988	1,056	2,044
Coal barges	do	653	2,047	2,700
Other craft, house boats, etc	do	76	48	124
Passengers	do	20,417	8,000	28,417
Lockages made	do	.....	.....	1,020

Lock No. 8, movable dam.—This dam was kept up two hundred and fifteen days during the year.

The maneuvers of the dam and the commerce at No. 8 are given in the following tables:

Maneuvers of dam.	Date.	Time taken. h.	Time taken. m.	Men employed.	Remarks.
Lowered	Dec. 14	1	45	5	No difficulty.
Raised	Dec. 21	8	30	4 to 5	Delayed 35 minutes by sand in pier recess.
Lowered	Dec. 29	2	00	5	No material difficulty.
Raised	May 4	12	45	4 to 5	About 4½ hours taken to remove winter deposit from foundations and repair chains.
Lowered	May 13	1	25	5	No difficulty.
Raised	June 1	9	30	5	Delayed 1 hour and 30 minutes by sand in pier recess and foul chains on weir.

	Through the lock.	Through the navigation pass.	Total.
Coal, bushels	3,028,800	17,690,000	20,718,800
Coke, tons		4,500	4,500
Lumber and logs, feet, B. M.	636,100	16,085,200	16,721,300
Railroad ties, number	4,425	110,900	115,325
Staves, do		950,000	950,000
Brick, do	6,000		6,000
Crib logs, linear feet	16,000		16,000
Salt, barrels		2,000	2,000
Miscellaneous freight, merchandise, produce, etc., tons	5,033	9,095	14,128
Steamboats, number	1,094	1,106	2,200
Coal barges, do	737	2,398	3,135
Other craft, do	54	53	107
Passengers, do	9,901	6,157	16,058
Lockages made, do			1,272

MISCELLANEOUS WORK.

Ironwork for navigation passes.—A contract for furnishing the ironwork for the navigation passes of Dams Nos. 9, 10, and 11 was made by Colonel Craighill with the Youngstown Bridge Company, of Youngstown, Ohio, the lowest bidder, by agreement dated October 5, and approved by the Chief of Engineers October 16, 1894.

This contract embraces about 635,000 pounds of wrought iron and steel, including 49,000 pounds of driftbolts and 337,000 pounds of cast iron.

The contractors were slow about getting started with the work, and experienced considerable trouble in getting the iron channels required for wicket horses and for the trestles of the service bridges.

They have now delivered at the locks altogether as follows, viz: Wrought iron, 71,290 pounds; driftbolts, 47,093 pounds; cast iron, 282,757 pounds. They are a good deal behind with the wrought work, particularly with the large parts, the bridge trestles, wicket horses, props, etc. They have this work now mostly or all under way in the shop, and are making fair progress with it.

Lock-gate anchorage.—The Van Dorn Iron Works Company, of Cleveland, Ohio, furnished the ironwork for the lock-gate anchorage and line hooks for Locks Nos. 9, 10, and 11, under regular contract with Colonel Craighill, approved August 10, 1894. It embraced 15,743 pounds of wrought and 10,310 pounds of cast iron. The last of the work was completed and delivered to the locks in November.

A sad occurrence connected with this contract was the death on October 23 of Mr. William S. Summers, civil engineer, while on duty inspecting this work for the United States. He dropped dead from heart disease in the shop at Cleveland as he stood looking at the forging of one of the anchor bars. Mr. Summers had been employed at various times on this improvement in the capacity of assistant engineer and inspector. He was a fine man, a cultured gentleman, a good engineer, energetic and thoroughly conscientious and reliable in every position. His death was a real loss to the work and to many people and in many ways.

Dredging.—The Government dredge, assisted by the towboat *Bee*, was steadily employed last season up to December 13, when operations were suspended for winter. The following is a brief summary of the work: The work of deepening and widening the towing channel at Scary in the No. 8 Pool, referred to in the last annual report, was continued until July 12. From July 13 to the 16th and from the 17th to the 25th, respectively, in dredging out the approaches of Lock 6 and Lock 2. From July 26 to October 6 was spent in the No. 2 Pool, dredging principally at the fol-

lowing points, viz, on the bar just below Mount Carbon, at Armstrong, Wheelers Island, and Eagle. The work consisted in straightening and widening the towing channels—making them 100 feet wide, and deepening them to let out boats of 6 feet draft in lowest water. Work in the No. 2 Pool, so far as proposed at present, was finished October 6 and the boats moved into the No. 3 Pool. From October 7 to November 5 working at Harvey near the head of No. 3 Pool. From November 6 to December 1, inclusive, with the exception of three days employed in dredging out the upper approach of Lock 3, was spent in the No. 4 Pool—dredging at Cabin Creek Shoal and in removing rock from channel with the dredge and crane boat near Belmont and Crown Hill. From December 3 to the 12th dredging a channel through the bar below Dam No. 2 with a view to correcting the side current at the foot of the lock. On December 13 the boats were laid up for winter and the crews, as far as expedient, discharged.

The repairs to the dredge described below were completed so that the dredge got to work this season on June 22. From this to the end of the month was spent in widening the towing channel at the head of Tyler just below Lock 6.

This dredging in the pools is mostly very hard digging—stone and coarse gravel (sometimes cemented) and occasionally clay hardpan. The cutting is light, generally from 1 to 3 feet deep, to reduce flat places to miter-sill depths, and a great deal of ground is worked over for the quantity of material handled. During the year about 27,000 cubic yards was dredged, nearly all of which was removed in dump boats.

Snags, etc.—In addition to regular work with the dredge, the towboat and crew, with the crane boat, took 568 stones and 36 snags and trees from the channel in various parts of the river during the year.

New dredge hull, etc.—An entire new hull, with new A frame, boom, dipper handle, spuds, etc., complete, was built for the old dredge machinery between March 1 and June 21. It was built at Lock No. 6, by purchase of materials and hired labor, assisted to a considerable extent by regular lock hands. The new hull is 75 by 30 feet, being 15 feet longer and 6 feet wider than the old one. In addition to a general overhauling and repair of the machinery a new independent swinging engine was added. Heretofore the dipper was swung in the old way by the main engine.

The dredge is now in good order, and is better equipped and adapted to the work than it ever was before.

Lock houses, etc.—Proposals for building five one and a half story, 16 by 30 feet frame houses—two at Lock 7 and three at Lock 8—for lock hands, were opened May 31. You have since made the contract with David Eagan, the lowest bidder, for all five of the houses (contract approved June 26), and work on the buildings at No. 7 has commenced.

During the year four small frame buildings belonging to the improvement—one at Lock 4, one at No. 5, and two at No. 6—were enlarged and made suitable for permanent houses for lock hands.

Three rough, one and a half story, 20 by 40 feet buildings were put up at Locks 9, 10, and 11, one at each place, last fall. They are being used to store ironwork for the dams, and will be used as permanent storehouses or shops after the completion of the works.

Telephone line.—In addition to ordinary work and repairs required to keep the Government telephone line in order, 33 new poles were put up during the year. The repairs to the line are with little exception made by the regular lockmen. The line now extends from Kanawha Falls to Lock No. 11, a distance of 93½ miles, connecting with each lock and with this office, making 12 stations in all.

Office work.—In addition to field and office work connected with the supervision of and estimates on the three locks and dams under construction, the most important items of engineering and drafting work during the year were as follows: Completion of drawings of ironwork for the navigation passes of Dams 9, 10, and 11, and specifications for same; details for cofferdams and timberwork of navigation passes of these three dams; drawings of dredge hull, etc., and of houses for lock hands; drawings of ironwork for the weirs of Dams Nos. 9, 10, and 11.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Lieut. Col. PETER C. HAINS,
Corps of Engineers.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 19, 1895.

Statement of number of tons of coal, including that manufactured into coke, shipped by river from mines on the Great Kanawha, for the several years named.

Year.	Tons.	Year.	Tons.
1875	161,932	1888	804,625
1876	200,962	1889	1,076,872
1877	207,346	1890	966,462
1881	385,148	1891	1,030,454
1883	614,818	1892	1,071,511
1884	736,843	1893	919,339
1885	712,493	1894	1,032,840
1886	714,465	1895	879,304
1887	929,335		

Tonnage of the Great Kanawha River for year ending June 30, 1895.

Articles.	Quantity.	Tonnage.	Articles.	Quantity.	Tonnage.
Coal.....bushels..	21,962,600	879,304	Shingles	2,039,000	306
Timber.....feet, B. M..	33,197,000	55,228	Brick	253,000	633
Staves, oak.....	1,182,000	3,546	Salt.....barrels..	3,365	500
Bark and wood for tanning .....cords..	2,040	3,772	Merchandise and produce in steamboats.....	.....	61,900
Hoop poles.....	261,000	130			
Railroad ties, oak.....	512,825	76,923	Total.....	.....	1,032,342

Total tonnage for:

1890 (Report Chief of Engineers, p. 2346)	1,127,232
1891 (Report Chief of Engineers, p. 2425)	1,225,355
1892 (Report Chief of Engineers, p. 2062)	1,360,750
1893 (Report Chief of Engineers, p. 2593)	1,116,537
1894 (Report Chief of Engineers, p. 1962)	1,222,530

The falling off in the coal shipment during the last year is due to two causes, viz, a dull market caused by the general depression in business and low water in the unslackwatered part of the river. There were but ninety-four days during the last fiscal year when medium-loaded (6-foot draft) coal barges could be taken out below the locks. Taking the last twenty-two years, this is about fifty days below the average time for coal shipment from Charleston down.

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Lieut. Col. PETER C. HAINS,
Corps of Engineers.

F F 2.

OPERATING AND CARE OF LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

During the fiscal year the expense of operating the locks and dams on the Great Kanawha River, in West Virginia, has been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section, which requires the rendition of an itemized statement of such expenses, the following is submitted:

Statement of expenses during the fiscal year ending June 30, 1895, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.

Lock and Dam No. 2:		
For wages of regular lock hands	$2,181.17	
For repairs and extra labor	312.51	
For supplies, as paints, oils, fuel, tools, etc	77.22	
For freights and transportation	7.05	
		$2,577.95
Lock and Dam No. 3:		
For wages of regular lock hands	2,288.00	
For repairs and extra labor	149.73	
For supplies, as paints, oils, fuel, tools, etc	81.65	
For freights and transportation	7.25	
		2,526.63
Lock and Dam No. 4:		
For wages of regular lock hands	2,284.33	
For repairs and extra labor	439.31	
For supplies, as paints, oils, fuel, tools, etc	129.08	
For freights and transportation	2.10	
		2,864.82
Lock and Dam No. 5:		
For wages of regular lock hands	2,393.33	
For repairs and extra labor	311.05	
For supplies, as paints, oils, fuel, tools, etc	151.74	
For freights and transportation	.75	
		2,856.87
Lock and Dam No. 6:		
For wages of regular lock hands	2,627.69	
For repairs and extra labor	438.06	
For supplies, as paints, oils, fuel, tools, etc	186.67	
For freights and transportation	9.25	
		3,261.67
Lock and Dam No. 7:		
For wages of regular lock hands	2,515.33	
For repairs and extra labor	410.46	
For supplies, as paints, oils, fuel, tools, etc	144.27	
For freights and transportation	1.50	
		3,071.56
Lock and Dam No. 8:		
For wages of regular lock hands	2,578.33	
For repairs and extra labor	121.41	
For supplies, as paints, oils, fuel, tools, etc	151.46	
For freights and transportation	7.40	
		2,858.60
Superintendence and central office expenses:		
Wages	3,261.02	
Rent and supplies	350.53	
Freights and transportation	21.00	
		3,632.55
Dredging at locks and part of running expenses of towboat:		
Wages of regular crew	1,606.33	
Repairs (including wages belonging to same) and supplies, as fuel, oils, paints, tools, etc	4,318.67	
Freights and transportation	27.17	
		5,952.17
Telephone line:		
Rent of instruments	90.00	
Repairs and supplies	143.22	
Freights and transportation	2.35	
		235.57
Gauge reports:		
Pay of gauge keepers and reporters at Hinton and Kanawha Falls		144.65
Total		29,983.04

F F 3.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

There are several old dams that are still in use, in a small way, for power for grist or saw mills. They are a real obstruction to navigation and should be removed. They have all been reported to the district attorney, as the law requires.

The Secretary of War has requested the Attorney-General to have proceedings instituted for the removal of the Frametown and Ashley dams. Meantime operations on the river have ceased, no work having been done in the fiscal year, except small repairs mentioned in the report of Mr. A. M. Scott, assistant engineer, appended.

The following are the amounts and dates of appropriations for improving Elk River, West Virginia:

June 18, 1878	$5,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	2,000
August 5, 1886	1,500
August 11, 1888	3,000
September 19, 1890	2,500
July 13, 1892	2,500
August 17, 1894	2,000
Total	28,500

Money statement.

July 1, 1894, balance unexpended	$79.01	
Amount appropriated by act of August 17, 1894	2,000.00	
		2,079.01
June 30, 1895, amount expended during fiscal year		180.45
July 1, 1895, balance unexpended		1,898.56
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		5,000.00

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W Va., June 29, 1895.

COLONEL: I have the honor to submit the following report on Elk River, West Virginia, for the year ending June 30, 1895.

The only work during the year directly on the improvement of the river was a small job of repairs to the Blue Creek Dike. This timber and stone dike (located 14 miles from the mouth of the river) was found in such condition last fall that some repairs were necessary to prevent material damage by high water. The work was done between the 11th and 18th of October, inclusive, by purchase of material and hired labor. About 825 linear feet of round timber, 125 cubic yards of stone, and 130 drift bolts were used in the repairs.

Old mill dams.—Little or no progress was made by the Department of Justice toward authorizing the removal of the old mill dams. In this connection the following communication is given:

DEPARTMENT OF JUSTICE, DISTRICT OF WEST VIRGINIA,
Charleston, W. Va., May 11, 1895.

COLONEL: Referring to previous correspondence concerning the obstruction of navigation of the Elk River by certain old dams existing thereon, I have to inform you that I referred the matter of the right of removal, in a summary way, of certain obstructions in said river on the part of the Government, as also the question of the criminal liability of parties continuing those obstructions, under section 10 of

the river and harbor act of September 19, 1890, to the Honorable Attorney-General for his opinion and recommendation, and have from him as his opinion and recommendation the following: "I would state that after careful consideration I am of the opinion that the provisions of section 10 of the river and harbor act of September 19, 1890, are not applicable for the punishment of parties continuing those obstructions—the dams appearing to fall within the exception of 'structures erected for business purposes'—nor to procure the removal of the dams otherwise than through proceedings under other provisions of law.

"I recommend that you reply to Colonel Craighill and the other officers who have communicated with you that you can not take summary action as requested, and that this Department can not instruct you to institute proceedings with a view to the removal of these obstructions unless requested so to do by the War Department."

Very respectfully,

C. C. WATTS, *U. S. Attorney.*

Col. WM. P. CRAIGHILL,
Corps of Engineers.

Since the above was written you have recommended that the Department of Justice be requested to institute such proceedings as are necessary to enable the War Department to have the two most troublesome dams on the river—the Frametown Dam and the Ashley Dam—removed.

This recommendation has been approved by the Chief of Engineers and the Secretary of War, and the Attorney-General requested to instruct the district attorney to institute proceedings accordingly. So far as this office is informed such instructions have not yet been received by the district attorney.

As shown by former reports, these old dams are now by far the most serious obstruction to navigation remaining in the river. In view of this it has been thought expedient to withhold the balance of the appropriation on hand to await the decision of the Department of Justice in regard to their removal.

The Clendennin Bridge.—During the year a bridge has been built across Elk River at Clendennin, 22 miles from the mouth of the river, according to location and plans approved by the Secretary of War. The bridge was completed during the present month and the final report on it mailed to you June 26.

It is an iron truss highway bridge with a 3-foot gauge railroad crossing it. It was built by Kanawha County. It has three spans, a main or channel span 150 feet, and one shore span of 70 and one of 80 feet, all measured between centers of piers. The main span has a clear headway of 38.04 feet above low water. This will enable the small towboats that work in Elk River to pass under, with smokestacks down, up to a 13-foot stage, which is as high as it is considered safe to tow in this part of the stream. The bridge is well located with reference to the current and channel, and it is believed will prove entirely satisfactory to the river interests.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Lieut. Col. PETER C. HAINS,
Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 27, 1895.

COMMERCIAL STATISTICS FOR ELK RIVER, WEST VIRGINIA.

Year.	Saw logs and lumber.	Railroad ties, oak.	Staves, oak.	Hoop poles.	Hickory spokes.	Tan bark.	Tonnage of timber products.
	Feet, B. M.					*Cords.*	*Tons.*
1883	5,200,000	100,000	898,334	.....	.....	.....	24,790
1884	5,975,000	125,000	1,122,500	.....	.....	.....	30,700
1885	5,100,000	250,000	1,433,750	.....	.....	.....	33,500
1886	15,361,000	250,000	1,845,000	.....	.....	.....	68,510
1888	15,900,000	330,000	1,210,000	.....	.....	.....	71,150
1889	15,750,000	295,000	1,600,000	500,000	350,000	.....	70,200
1890	26,650,000	330,000	1,380,000	150,000	568,000	300	89,880
1891	27,995,000	412,500	800,000	125,000	200,000	500	103,700
1892	44,400,000	380,000	1,405,000	.....	.....	240	139,800
1893	37,516,000	353,000	1,390,000	.....	.....	612	125,400
1894	21,844,000	302,000	900,000	.....	.....	800	92,630
1895	31,160,000	280,000	1,662,000	230,000	.....	1,800	112,100

Of the saw logs and lumber during the last year about 20,000,000 feet were poplar, 8,000,000 oak, the remainder being mainly hemlock, walnut, maple, and hard pine.

The general merchandise and produce carried on the river in push boats and canoes is estimated at 2,800 tons. In addition, about 5,500 tons of sand was dredged from the bed of the river near Charleston and boated to adjacent landings for building purposes. This makes the total for the year, with the timber products as above, 120,400 tons.

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Lieut. Col. PETER C. HAINS,
Corps of Engineers.

F F 4.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

Owing to the lateness in the working season of the last appropriation, operations on the river were necessarily confined to September and October, 1894, and the balance remaining of the $8,000 did not justify resumption in the summer of 1895.

The work of the year was over a stretch of the river from its mouth to 14⅞ miles above. The details will be found in the attached report of Assistant Engineer William Proctor Smith.

The following are the amounts and dates of appropriations for improving Gauley River, West Virginia:

August 11, 1888	$3,000
September 19, 1890	3,000
July 13, 1892	3,000
August 17, 1894	3,000
Total	12,000

Money statement.

July 1, 1894, balance unexpended	$15.42
Amount appropriated by act of August 17, 1894	3,000.00
	3,015.42
June 30, 1895, amount expended during fiscal year	1,931.05
July 1, 1895, balance unexpended	1,084.37
Amount (estimated) required for completion of existing project	63,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

BALTIMORE, MD., *November 19, 1894.*

COLONEL: I have the honor to report the following operations on the improvement of the Gauley River, West Virginia, for the season of 1894.

Orders were received on the 27th of August to go to work and on the 28th preparations for the same were begun by calking boats, sharpening tools and steel, and looking up laborers.

On the 1st of September a force of ten men was removing the loose rock, sand, and gravel from the channels in the shoals, which had accumulated during the period of nearly two years which had elapsed since the previous work, during which time there was very heavy ice in the winter of 1892–93.

From the 1st to the 18th of September, inclusive, the boat channel, from the mouth of Gauley River to the foot of the first shoal in the "Roughs," a distance of 12¼ miles, was improved, the details of which are as follows:

	Cubic yards.
Loose rock removed from eleven shoals between the mouth of Gauley River and Twenty-Mile Creek, 5 miles, amounting to	90
At Twenty-Mile Creek, loose rock and a shoal of sand and gravel removed, amounting to	120
Loose rock removed from seven shoals between Twenty-Mile Creek and Mill Shoal, 7¼ miles above the mouth of Gauley River, amounting to	45
At Mill Shoal a deposit of sand and gravel was removed from its lower end, 170 feet in length of the south wing wall was raised 1 foot higher, and 320 feet of north main wall was rebuilt, making it 2 feet higher, all amounting to	286
Loose rock removed by hand and small bowlders by blasting from seven shoals between Mill Shoal and the first shoal in the "Roughs," 12¼ miles above the mouth of the river, amounting to	188
Total	729

At this point begin what are called the "Roughs" of Gauley, 26 miles in extent, through which the project calls for a channel 30 feet wide, with a grade as to depth of 2 feet above zero or ordinary low water, for the purpose of floating logs.

The natural channels are now obstructed by large bowlders at some points and at others pockets are formed into which the logs float, and it is difficult and expensive to get them out.

The removal of these bowlders is the object of this work, and it is similar at all the points mentioned below, where operations were carried on this season.

Table showing the work in the "Roughs" of Gauley River, West Virginia, for the season of 1894.

Name of shoal.	No.	Length.	Fall.	Bowlders.	Bowlders blasted.	Distance from the mouth of Gauley River.
		Feet.	*Feet.*	*Number.*	*Cubic yds.*	*Miles.*
Beaver Pond	1	600	9.1	7	35	12¼
	2	900	8.7	(*)	(*)	12½
Camp Shoal	3	500	.8	(*)	(*)	12¾
	4	900	14.8	5	178	13¼
Sugar Creek	5	320	2.7	14	155	13½
	6	414	4	13	91	13¾
Horse Shoe	7	1,126	7.9	32	257	14
	8	322	3.5	7	27	14¼
	9	232	.7	2	129	14½
Little Beech Run	10	200	1.1	7	46	14¾
	11	.....	.....	.....	.....	14¾
Total	.....	5,514	58.3	87	918	.....

* Not worked at this season.

At the foot of Shoal No. 4 the rocks are blasted down to the zero level of the water. At No. 5 there are no rocks higher than 2 feet above zero. At Shoals 6 and 7 there are on the right bank natural channels, dry during the summer, which would answer every purpose for logging were it not that the current tends to the left bank, which necessitated making the improvements there; the channels referred to, however, may aid materially when the water gets very high.

At Nos. 8 and 9 there are two chutes, and when the water gets up both will be available. This is desirable at the latter shoal, for the rock is 6 inches above what the project calls for, and to take this out, it was thought, would involve an expense greater than the benefit derived.

At No. 10, the last worked at this year, the conditions as to width and depth have been complied with.

As will be seen from the table, the combined lengths of the shoals in the "Roughs" worked through this season amounts to three-fourths of a mile in a river space of 2¾ miles, from which were taken 87 bowlders containing 918 cubic yards.

The fall over these shoals is 53.3 feet, which, added to the fall, 46.4 feet, in the Bateau Channel, gives the difference of level between the foot of the Eleventh Shoal in the "Roughs" and the mouth of the stream at Gauley Bridge, 99.7 feet. This distance is nearly 15 miles.

The powder purchased was 4' Hercules, 50 per cent nitroglycerin, of which was used	pounds	500
Double-taped fuse	feet	1,150
Exploders or caps		350
Holes drilled		237
Blasts fired		240
Drilling	feet	225

As will be observed there were more blasts than holes drilled. This arises from the fact that some of the cartridges were fired on top of and under the bowlders

Out of the fifty-one working days, none were lost by bad weather.

It rained on eleven days, but generally in showers.

Of the two rises during the season, the highest was not quite 2 feet.

The average number of men employed during the whole period, per day, was 12½.

The wages of the men in September were $1.20 per day of eight hours. When the weather got colder in October, and it required more time for the men to carry in their supplies, their wages were increased to $1.50 for the same number of hours.

The cost of the loose rock, sand, and gravel this season was 55½ cents per cubic yard, and the solid rock 99 cents per cubic yard; the former is less than in 1891 and more than in 1892, but is a fair average for the past three seasons. The latter is greater than in 1891 and less than in 1892, but it is also a good average for the seasons mentioned.

Camp was established at the foot of the Roughs on the 18th of September and was removed three times before the work closed out on the 25th of October.

A boarding-house keeper supplied the men until the 13th of October, when he quit, saying he was making nothing. The men then went to what they call "shantying," buying their own provisions and doing their own cooking. This was cheaper for them but delayed the work to some extent, as time was lost in getting in supplies, for the main portion of these had to be brought 9 miles, and over the last 4 they had to be carried on the backs of the men along paths cut out by themselves on the banks of the river.

The gauge readings were, the highest 0.15 foot above and the lowest 1.75 feet below ordinary low water.

One-half of the time the gauge readings were either below or nearly down to 1½ feet below zero.

The rock boats were left at the foot of the Roughs and the skiffs relied on for transportation; in fact, the water was so low, and even if it had not been, the channels in the Roughs are not made for boating, nearly everything had to be carried around the shoals; and as their occurrence was frequent, it took more time to load and unload than it did to carry. Anyhow the men had as much as they could do to get the empty boats through.

For blacksmithing purposes coal was found at Sugar and Horseshoe creeks, near their mouths.

Camp at Little Beech Run was struck on the morning of the 26th and the party started to move, arriving at the foot of the first shoal in the Roughs the night of the 27th. Sunday was spent here and a start was made again on the 29th, arriving at Gauley Bridge on the morning of the 31st after encountering bad weather, where the portable property was stored in, and the boats under and adjoining, Mr. James H. Miller, jr.'s, warehouse.

Four sawmills are in operation on Gauley River and its tributaries, three of these ship by railroad and the fourth on Otter Creek, which empties into Peters Creek, will haul, so it is reported, its lumber to the mouth of Little Elk Creek, 10 miles above Gauley Bridge, and ship by boats. There are enough bateaux and flatboats on the river to ship this lumber, say 1,000,000 feet.

At one sawmill (Burdett's), about three-fourths of a mile above the mouth of Gauley on the left bank of the river, the sawdust is piled up along the river bank some little distance back. This is slowly burning all the time and will no doubt be gradually consumed. What effect a rise in the river may have on this sawdust can not be stated, but at present there seems to be none going into the stream.

Since the last work on Gauley, in the fall of 1892, the Chesapeake and Ohio Railway has completed a branch road from its junction on the main line at Narrow Falls, New River, 1 mile above Gauley Bridge, to the mouth of Twenty-Mile Creek, 6 miles, and thence up the creek 9 miles.

At the terminus a coal mine was opened, but the seam was lost and the works abandoned and buildings leased to a lumber company. Now it is reported that the branch road is to be extended 4 miles and new coal works are to be operated.

The Kanawha and Michigan Railroad, a branch of the Toledo and Ohio Central Railroad, is in operation from Charleston, W. Va., to a junction with the Chesapeake and Ohio Railway branch, about 200 yards east of Gauley River, which it crosses at its mouth.

Considerable activity is being exhibited in the way of developing the coal interests of this region.

The time from November 1 to date has been utilized by settling up accounts, paying off the laborers, collecting data for, and in writing this report.

Respectfully,

WM. PROCTOR SMITH,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers.

COMMERCIAL STATISTICS FOR GAULEY RIVER, WEST VIRGINIA.

Year ending June 30—	Saw logs.	Lumber.	Staves.	Coal.	Shingles.	Tonnage of timber.	Produce, etc.	Total from Gauley.	Merchandise to Gauley.
	Feet.	*Feet.*		*Tons.*			*Tons.*	*Tons.*	*Tons.*
1888	691,800	2,535,300	177,400	.....	.....	7,121	26	7,151	750
1889	890,400	3,615,000	274,200	.....	.....	9,491	78	9,569	1,322
1890	384,800	4,452,500	.....	.....	.....	9,676	90	9,766	1,985
1891	384,700	4,701,300	100,000	.....	.....	10,347	89	10,436	1,964
1892	261,170	5,249,200	1,200,000	.....	111,000	9,527	103	9,630	3,083
1893	302,000	5,470,000	113,700	.....	75,000	9,457	114	9,571	2,405
1894	523,000	4,765,000	483,000	525	.....	8,506	213	9,244	2,398
1895	2,000,000	5,000,000	1,000,000	2,000	50,000	.....	.....	19,050	4,500

The estimate for 1895 was furnished by Mr. J. H. Miller, jr., of Gauley Bridge, W. Va.

F F 5.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

There has been no work on this river in the year ending June 30, 1895.

The following are the amounts and dates of appropriations for improving New River, Virginia and West Virginia:

August 14, 1876	$15,000	August 2, 1882	$12,000
June 18, 1878	15,000	August 5, 1886	10,000
March 3, 1879	12,000		
June 14, 1880	24,000	Total	112,000
March 3, 1881	24,000		

Money statement.

July 1, 1894, balance unexpended	$2,341.79
June 30, 1895, amount expended during fiscal year	32.85
July 1, 1895, balance unexpended	2,308.94

F F 6.

PRELIMINARY EXAMINATIONS OF BIG COAL AND LITTLE COAL RIVERS, WEST VIRGINIA.

[Printed in House Ex. Doc. No. 82, Fifty-Third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report of September 29, 1894, by Col. Wm. P. Craighill, Corps of Engineers, of the results of preliminary examinations of Big Coal River and Little

Coal River, West Virginia, made to comply with the requirements of the river and harbor act of August 17, 1894.

Colonel Craighill is of opinion that these rivers are not worthy of improvement by the General Government. I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., September 29, 1894.

GENERAL: In compliance with your instructions of August 20 I have the honor to report on the subject of a proposed preliminary examination of Big Coal and Little Coal rivers, West Virginia.

Little Coal is only a branch of the same river. A report covering these rivers was made in 1887, and may be found in print in the Annual Report of the Chief of Engineers for 1887, Part III, pages 1929–1933.

I have examined into present conditions, and my conclusion is the same as in 1887, that these rivers are not "worthy of improvement by the General Government."

One of the principal owners of lands on the rivers writes as follows, under date of September 10, 1894:

"Myself and other Coal River landowners have now a fair prospect of securing a railroad to our lands," and in my opinion the railroad is what is really needed for that locality under existing circumstances.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F 7.

PRELIMINARY EXAMINATION OF ELK RIVER, WEST VIRGINIA, WITH A VIEW OF LOCKING AND DAMMING SAME.

[Printed in House Ex. Doc. No. 67, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report of November 5, 1894, by Col. William P. Craighill, Corps of Engineers, giving results of the preliminary examination of Elk River, West Virginia, "with a view of locking and damming same," as prescribed by river and harbor act of August 17, 1894.

It is the opinion of Colonel Craighill, in which I concur, that the improvement of Elk River by locks and dams is not such as to be worthy to be undertaken by the United States at this time.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., November 5, 1894.

GENERAL: The river and harbor act of August 17, 1894, called for a preliminary examination of "Elk River, West Virginia, with a view of locking and damming same," which was placed in my charge by your instructions of August 20.

This subject has been already reported upon in December, 1890 (see p. 2434, Annual Report Chief of Engineers, Part IV, 1891). A reexamination was, however, made of the river in October, 1894. The report of 1890 contained the following statements:

A survey of this river was made in 1875, a report of which may be found in the Annual Report of the Chief of Engineers for 1876, Part II, pages 166–176. Estimates were given for two methods of improvement. One of these consisted in the removal of snags, rocks, overhanging trees, etc., and the cutting of narrow sluices through the rapids and shoals, the chief interests to be subserved being those of lumbering and rafting, as also the movement by smaller boats of much country produce, with a return of merchandise. This project was estimated to cost $100,000. Under this project the first appropriation was made of $5,000 June 18, 1878, and the last of $2,500 by the river and harbor act of September 19, 1890. The amount expended up to this date has been $21,048.40, with great advantage to the navigation of the river and to the manifest benefit of the country through which it flows. This method of improvement should be continued. Its progress has been detailed annually in the reports of the Chief of Engineers.

The second method of improvement estimated for in the report of 1875 was for locks and dams. The amount was $1,500,000.

This has not been entered upon, and in my judgment the present and prospective needs of commerce do not warrant it. Should, however, Congress decide otherwise, it should be with the knowledge that the coal trade now requires larger locks than were deemed necessary fifteen years ago, and an estimate for an improvement by locks and dams must be increased to $2,800,000 if carried to Sutton, 100 miles from the mouth of the river, or $1,900,000 if carried to a point a little above Big Otter Creek, about 67 miles from the mouth of the river.

Then I was of the opinion, and so stated, that I did not consider the conditions of the case would justify the expense of improving the river by locks and dams.

Since that time the improvement of the river has continued in accordance with the project adverted to above, with manifest benefit.

The principal obstruction to navigation under the existing project now consists of several old milldams put in the river years ago under the authority of the State. These are now of very little value to anyone, but their removal has been objected to by a few. They have been reported under the law to the United States district attorney for West Virginia as obstructions to navigation. Before taking legal action he has asked the Department of Justice for an opinion on the point whether the United States can not proceed summarily to remove these dams in whole or in part, as the interests of the navigation may require.

Since my report of 1890 there has been little change in the commercial condition of the valley. The most important thing that has occurred is the beginning of the Charleston, Clendenin and Sutton Railroad, which was completed up to Clendenin, a distance of 20 miles, in May, 1892, and has been in operation since then. A good deal of lumber, staves, etc., has been shipped out by this road, and some coal. The best coal field, however, begins just above Clendenin. Arrangements to go on with the construction of this road, for some distance at least above Clendenin, have recently been made and work on it is now in progress.

After a careful reconsideration of the subject I find myself of the same opinion as in 1890, viz, that in view of "the present and prospective needs of commerce," "the improvement of Elk River, West Virginia, by locks and dams is not such as to be worthy to be undertaken by the United States at this time."

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX G G.

IMPROVEMENT OF CERTAIN RIVERS IN KENTUCKY AND WEST VIRGINIA.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tradewater River, Kentucky.
2. Lock No. 2, Green River, at Rumsey, Ky.
3. Green River above mouth of Big Barren River, Kentucky.
4. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
5. Rough River, Kentucky.
6. Kentucky River, Kentucky.
7. Operating and care of locks and dams on Kentucky River, Kentucky.
8. Licking River between Farmers and West Liberty, Ky.
9. Big Sandy River, West Virginia and Kentucky.
10. Levisa Fork of Big Sandy River, Kentucky.
11. Tug Fork of Big Sandy River, West Virginia and Kentucky.
12. Guyandotte River, West Virginia.
13. Little Kanawha River, West Virginia.
14. Operating and care of lock and dam on Little Kanawha River, West Virginia.

EXAMINATIONS.

15. Licking River, Kentucky, for an ice harbor, including lock and dam at a point about 3 miles from its mouth.
16. Guyandotte River, West Virginia.
17. Little Kanawha River, West Virginia.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 9, 1895.

GENERAL: I have the honor to transmit herewith annual reports on work under my charge at the close of the fiscal year ending June 30, 1895.

Capt. H. E. Waterman, Corps of Engineers, and First Lieut. James J. Meyler, Corps of Engineers, have been on duty under the direction of this office throughout the year.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

G G 1.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The Tradewater is a tributary of the Ohio, and empties into it 79 miles below Evansville, Ind.

The project for the improvement, adopted in 1881, contemplated originally the removal of obstructions, such as bars, snags, etc., so as to open up to navigation 22 miles of the river by forming a channel with a minimum width of 40 feet and a minimum depth of 2½ feet for six months in each year. The survey upon which the project was based covered 41 miles of the river, and the scope of the work has been extended to embrace this, although the depth of 2½ feet can only be secured for about five months each year in the upper portion.

The river has been thoroughly gone over from its mouth to the upper limit of the improvement, 41½ miles above, and while the improvement is not permanent, the obstructions to navigation, such as snags, sunken logs, etc., being liable to re-form after each high water, no further appropriation at the present time is deemed requisite, as the unexpended balance from former appropriations will be sufficient for the ensuing fiscal year.

No work was done during the past fiscal year beyond caring for property.

APPROPRIATIONS.

March 3, 1881	$3,000
August 2, 1882	3,500
July 5, 1884	2,000
August 5, 1886	2,000
August 11, 1888	6,000
Total	16,500

Money statement.

July 1, 1894, balance unexpended	$761.35
June 30, 1895, amount expended during fiscal year	24.00
July 1, 1895, balance unexpended	737.35
July 1, 1895, outstanding liabilities	18.00
July 1, 1895, balance available	719.35

NOTE.—It has been impossible to obtain any commercial statistics.

G G 2.

RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY, KENTUCKY.

REBUILDING LOCK NO. 2.

In the deficiency act of March 3, 1893, an appropriation of $65,000 was made for rebuilding Lock No. 2, Green River. A project and estimate for the expenditure of this amount was submitted under date of March 23, 1893, and approved April 12, 1893.

The original estimate of cost of this work was $170,000, and in view of the fact that the old lock was in a dangerous condition it was deemed advisable to commence the construction of the upper end of the new lock, and then, by filling in between the land wall of the new lock and

the river wall of the old lock, to secure the latter, and in this way be able to continue the use of the old lock for navigation. The plan was to build an auxiliary dam in the pool above the lock, connected by an arm at one end with the head of the old lock, and at the other end by another arm with the dam; then to tear out the section of old dam between the arms of the new dam and construct the cofferdam for the new lock entirely in the lower pool. The money available, it was estimated, would build the head of the new lock complete to a short distance below the hollow quoins on top of the walls, stepping down to points on the footing courses 88 feet from the upper end of each wall, rebuild the dam to connect with river wall of new lock, and fill in between the land wall of the new lock and the river wall of the old lock. The new lock is located alongside the old one, on the water side. Owing to the failure on the part of the contractors for stone to deliver same within the time specified in contract, the original plan could not be carried out, and the upper end of lock was incomplete at the close of the last fiscal year.

As the river and harbor act of 1894 did not become a law until August 17, it was not deemed advisable to attempt to do more than excavate the site for the lower end of the lock before winter. The necessary coffer was built and the excavation for the lock and a portion of the lower entrance made before cold weather set in. The material excavated was a tough, fibrous, slaty rock that blasted poorly.

Under date of February 11, 1895, a contract was entered into with the Evansville, Ohio and Green River Transportation Company to furnish the stone required to complete the lock. The delivery has been prompt, to date, and at the close of the fiscal year the laying of stone had been commenced.

For details of work done attention is invited to the report of First Lieut. James J. Meyler, Corps of Engineers, attached hereto.

APPROPRIATIONS.

March 3, 1893	$65,000
August 17, 1894	105,000
Total	170,000

Money statement.

July 1, 1894, balance unexpended		$29,059.47
Amount appropriated by act of August 17, 1894		105,000.00
		134,059.47
June 30, 1895, amount expended during fiscal year:		
Vouchers	$12,986.46	
E. & H.*	15,711.88	
		28,698.34
July 1, 1895, balance unexpended		105,361.13
July 1, 1895, outstanding liabilities	7,383.99	
July 1, 1895, amount covered by uncompleted contracts	32,120.00	
		39,503.99
July 1, 1895, balance available		65,857.14

*Amount paid by Treasury Department in settlement of Eigenmann & Hollerbach claim under their contract.

Abstract of proposals received and opened February 4, 1895, for furnishing stone for improving Green River, Kentucky, rebuilding Lock No. 2.

No.	Name and address of bidder.	Special stone, 80 cubic yards.	Cut stone, dressed face, 870 cubic yards.	Cut stone, quarry face, 573 cubic yards.	Backing stone, 3,064 cubic yards.	Coping stone, 268 cubic yards.	Total.
1	Bedford, Weikel & Nugent, Evansville, Ind	$12.90	$10.05	$7.15	$5.60	$11.80	$34,198.25
2	Evansville, Ohio and Green River Transportation Co., Evansville, Ind	11.75	10.00	7.00	5.00	11.75	32,120.00
3	Chas. L. Cornwell, Louisville, Ky	18.00	12.50	10.60	6.50	15.00	43,334.80
4	Eichel & Arnold, Evansville, Ind	15.00	10.62	9.62	5.65	15.00	37,283.26
5	Sturm & Cramer, Parkersburg, W. Va	15.00	11.00	9.00	7.00	14.00	41,127.00
6	J. C. Thomas, Ironton, Ohio	20.00	11.00	8.00	6.50	14.00	39,422.00

Contract awarded to the Evansville, Ohio and Green River Transportation Company.

Abstract of contracts for rebuilding Lock No. 2, Green River, Kentucky, in force during the fiscal year ending June 30, 1895.

Contractor.	Nature of contract.	Date.	To expire—
Evansville, Ohio and Green River Transportation Co.	Furnishing stone	Feb. 11, 1895	July 1, 1895*

* Extended to August 1, 1895.

REPORT OF FIRST LIEUT. JAMES J. MEYLER, CORPS OF ENGINEERS.

BOWLING GREEN, KY., *June 30, 1895.*

MAJOR: I have the honor to submit the following report of operations on Green River, Kentucky, in rebuilding Lock No. 2, for the fiscal year ending June 30, 1895.

The work on the new lock was begun in June, 1893, and suspended in the following December. It was not resumed again until August 23, 1894, a few days after the act of August 17, 1894, appropriating $105,000 for the completion of the lock. It was then too late in the season to advertise for the stone necessary to complete the lock, and it was deemed advisable to do only such preliminary work as would allow an early start to be made this season on laying masonry in the lock walls.

Constructing cofferdam.—Began work August 23. Removed 239 cubic yards of earth and sand, by wheelbarrow, from portion of bottom on which coffer was to rest. Began laying timber in coffer August 29, and completed its construction on September 13. This coffer is to surround lower end of new lock, and was built onto lower end of coffer surrounding head of lock. The cofferdam was built of 9 by 9 inch sawed gum timber, and was sheathed on both inside faces with 1-inch oak, the joints being covered with three-fourths-inch battens.

Dimensions of coffer.—Length, 456 feet; width, 10 feet, and height, 5 feet.

There was used in its construction 27,236 feet, B. M., of 9-inch gum; 5,603 feet, B. M., of 1-inch sheathing; 2,276 feet, B. M., of three-fourths-inch battens, and 2,131 feet, B. M., of 6 by 3 inch oak ties. The coffer was filled with 760 cubic yards of earth and leaves, taken from upper island. It was pumped out on September 13.

Excavating for lock chamber and wall foundations.—This work was begun on September 14, it first being necessary to remove 200 cubic yards of sand that had been deposited on the bottom during the high waters of the previous spring. The material to be excavated was a very tough shale, so difficult to break up that the blasting and removal of it was necessarily slow work. After the excavation had been carried to a depth that rendered blasting impracticable, the remainder of the stone was loosened by wedging and hammering with sledges. The excavation was completed October 22, there having been removed, in all, 5,284 cubic yards in place. About one-third of this amount was removed by derrick and dump-box, and the rest by wheelbarrows.

Building lock walls.—It was considered very desirable to build up the walls at the head of the lock to a greater height, in order to make them more secure against extreme high stages of water. Authority was obtained for the purchase of stone in open market, and in this manner were obtained 168 cubic yards of quarry face stone and 177 cubic yards of backing. This amount of stone, together with the dressed face and special stone on hand, made it possible to build up the walls in head of lock from course H to course M, inclusive. The laying of masonry was begun on November 28 and carried on until December 20, when all the stone on hand had been used.

Both walls were completed up to course M, and the inner face stones of N were also set. These walls run back from head of lock to a short distance below hollow quoins on top of walls, and are then stepped off to the lowest course, A, which runs back about 88 feet from head of lock. Each course is 2 feet thick. During the progress of the above work, from August 23 to December 20, a certain amount of miscellaneous work was always found necessary, thus: At the beginning of the work derricks had to be erected, one in the lock chamber and another on the lower end of the coffer; an anchorage crib was set in the river for the guy of the latter derrick; the breakwater was backed with a barge-load of earth and leaves to stop up leaks; two new dump boxes were built; pumps, boilers, and engines were put up, and sheds built over them; 100 feet of tramway was laid; stones for corners of walls and gate recesses, and all necessary "closers," were cut; the center was removed from the arch of cross culvert, and centers were built to support arches of filling culverts, and the joints of courses in both land and river walls were pointed. The U. S. dredge boat *Lermond* was engaged during the same period in cutting out entrances to the new lock. In cutting out an upper entrance there were dredged and removed from the upper island 20,140 cubic yards of material, 51 stumps, 7 saw logs, 3,087 linear feet of old crib timber, and one old sunken barge. In cutting out a new lower entrance there were removed 13,990 cubic yards of sand and earth, 3 saw logs, 274 pieces of timber, and 1,480 linear feet of old cribbing.

At the close of the working season, in the latter part of December, all tools, appliances, etc., were properly stored away, and part of the plant was brought to Bowling Green and put in winter quarters.

Work on the lock was resumed last month, and the usual amount of preliminary work had to be done before any masonry could be laid in the lock walls, thus: It was necessary to construct in the lock excavation two foundation cribs, 16 by 16 by 14 feet high, upon which were erected and completed two new derricks with 60-foot masts and booms. It was also necessary to build, inside of the coffer, a foundation crib 20 by 29 by 10 feet high, upon which was placed the pumping apparatus. The cofferdam was repaired by replacing 70 cubic yards of earth and leaves that had been washed out by high water and by backing one side with 20 cubic yards of earth and leaves to stop leak; 300 linear feet of tramway was built on lower island, and two new tram cars constructed for handling the stone stored on the island; the excavation was emptied on the 13th instant, and 130 cubic yards of mud was removed from the bottom, which was cleaned for concreting. Within the last few days masonry work has been resumed, and up to date there has been laid 90 cubic yards of concrete for wall foundations and 100 cubic yards of masonry in the land wall.

Mr. B. O. Lermond, assistant engineer, is in local charge of the work at this lock.

Respectfully submitted.

JAMES J. MEYLER,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

NOTE.—For commercial statistics and list of boats, see report for operating and care, etc., Green and Barren rivers, Kentucky.

G G 3.

IMPROVEMENT OF GREEN RIVER, KENTUCKY, ABOVE MOUTH OF BIG BARREN RIVER (LOCK NO. 5).

The river and harbor act of July 13, 1892, contained the following:

Improving Green River, Kentucky, above the mouth of the Big Barren River, for Lock Number five, according to report and recommendation of Major D. W. Lockwood, Corps of Engineers, United States Army, submitted August eleventh, eighteen hundred and ninety-one, fifty thousand dollars.

This work having been assigned to me by Department letter of July 14, 1892, calling for a project for expenditure of the amount appropriated under date of July 25, 1892, I had the honor to state as follows:

Before any definite project can be submitted it will be necessary to locate the site of the lock, as the old locations have been but approximate. This will be done at an early date, when plans, etc., for the lock and dam, together with plats of land required, will be submitted for approval.

A location for this lock was originally selected by Mr. Alonzo Livermore, State engineer of Kentucky, more than fifty years ago. The

point selected was at Floyd's Landing, 20½ miles above Lock No. 4, Green River. In 1879 an examination was made by R. H. Fitzhugh, assistant engineer, under the orders of the late Lieut. Col. William E. Merrill, Corps of Engineers, with a view to selecting a site for this lock, and he adopted the selection made by Livermore, with an alternate location just below the mouth of Bear Creek. Assistant Engineer Fitzhugh placed the lock on the right bank of the river at Floyd's Landing, against a rock bluff considerably higher than the lock walls would be and in the hollow bend of the river, so that drift, etc., would collect in the upper entrance. I am of the opinion that Mr. Livermore must have placed the lock on the point side, but here there would be no opportunity for a rock foundation, as the bend of the river is, so far as could be determined, sand and gravel to a depth of over 20 feet.

In the fall of 1892 Assistant Engineer Westerfield examined the location at Floyd's Landing and an additional site below Bear Creek, but no definite conclusion was reached, as neither site was found to be favorable.

In view of the fact that the country through which Bear Creek runs is rich in mineral deposits, coal, and iron, it was deemed advisable to locate the lock and dam below the mouth of Bear Creek; a short distance below the mouth the river is straight, and the bottom composed of gravel and sand. This location was surveyed and developed, and a request made that a board of officers of the Corps of Engineers be convened to decide the question of site, surveys of other localities being submitted at the same time. The report of the board, dated August 4, 1894, was in favor of the site below the mouth of Bear Creek, and this action was approved by the Chief of Engineers. Since that time, with the aid of an attorney employed for the purpose, efforts have been made to straighten out the question of title. Part of the property had been left to be equally divided between eight heirs. These heirs had transferred shares from one to the other with imperfect or unrecorded deeds.

Some of the heirs had moved away, and it was only within a very recent time that an abstract, indicating that a perfect title was possible, could be made. Old deeds have been made over, the recording of them and others completed, and it will now be possible, it is thought, to obtain the requisite land by purchase.

APPROPRIATIONS.

July 13, 1892	$50,000
August 17, 1894	25,000
Total	75,000

Money statement.

July 1, 1894, balance unexpended	$47,431.70
Amount appropriated by act of August 17, 1894	25,000.00
	72,431.70
June 30, 1895, amount expended during fiscal year	501.56
July 1, 1895, balance unexpended	71,930.14
July 1, 1895, outstanding liabilities	2,173.95
July 1, 1895, balance available	69,756.19
Amount (estimated) required for completion of existing project	105,673.20
Amount that can be profitably expended in fiscal year ending June 30, 1897	105,673.20

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

NOTE.—For commercial statistics and list of boats, see report for operating and care, etc., Green and Barren rivers, Kentucky.

G G 4.

OPERATING AND CARE OF LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

The United States acquired possession of the locks and dams December 11, 1888, by purchase of the unexpired lease of the Green and Barren River Navigation Company, the legislature of the State of Kentucky having ceded them, with lands and appurtenances pertaining thereto, to the United States upon condition that the latter should extinguish the claim of the navigation company to take tolls and to exercise control over said rivers.

At the time of acquiring possession four of the locks were being operated, to wit, Nos. 1, 2, and 4, Green River, and No. 1, Barren River. The river wall of No. 3, Green River, was down, having fallen into the river about the first of the year. Both walls of No. 2 were, and had been for years, in a dilapidated condition, the land wall being prevented from tumbling into the pit only by reason of being anchored back to cribs filled with stone.

At No. 1, Barren, the grillage upon which the walls rested had been undermined at the lower end of the land wall so that the wall was badly cracked and appeared liable to yield at any time. The dams were nearly all in bad condition, the timber of the downstream slopes being badly decayed.

The walls at No. 3, Green, and No. 1, Barren, were completed in time to reopen the river to through navigation November 10, 1890.

The dams of No. 1, Barren, and No. 2, Green, have been rebuilt entirely from the crests forward, and the latter has been straightened by taking out the break in direction that formerly existed, and which made a fore bay for logs for a small mill on the abutment side of the river. This dam now extends directly across the river from the lock. The old guide cribs at upper and lower entrances of the locks had become useless by reason of their tumbled-down condition; these have been rebuilt, and the amount of dredging required after every rise has been materially lessened. The areas immediately behind the land walls of locks have been graded and paved, the United States land sown with grass seed and fenced in.

Eight lock keepers' dwellings have been built and two old ones put in thorough repair.

At Dam No. 1, Green River, considerable trouble is always experienced after a high rise in the Ohio River, which washes out the backing above the dam. The practice has been when the water falls and a pressure against the upstream face of the dam is developed to throw hickory sawdust into the river just above the dam. This is washed and drawn into the crevices, etc., and effectually stops the leaks until after another rise from below. The lock entrances have all been dredged during the year, some of them several times.

At Lock No. 1, Green River, new upper gates were built and hung, and at the same time iron hollow quoins were put in. The sandstone of which this lock is constructed is soft and easily broken. The old stone quoins were badly worn and chipped, so that considerable leakage occurred, and besides were undercut at the bottom. The iron quoins were made in sections bolted together and to the wall, and the space between them and the old masonry filled in with cement. The lower gates will have to be rebuilt shortly, and it is proposed to put in iron hollow quoins for them. Notwithstanding the fact that this lock is built on a rock foundation, the masonry rests directly on a timber grillage. The spaces between the timbers were originally filled in with

concrete and the chamber floor with 2-inch plank. The planking is all gone, and much of the grillage timbers is also gone. A number of small cracks have appeared lately in the lower courses of masonry, and it appears to be advisable that the pit be coffered and pumped out and the spaces between the grillage timbers, under the walls, and in the pit filled with cement, and a heavier floor than was formerly used be put in.

At the other locks the ordinary repairs have been made, and in the Barren River the channel in several close places has been widened and deepened by dredging.

For details of work done attention is invited to report of Lieut. James J. Meyler herewith.

Leases in force for year ending June 30, 1895.

Location.	Lessee.	Date.	To expire.
Lock No. 2, Green	Livers & Welborn	Jan. 1, 1892	Jan. 1, 1912
Lock No. 2, Green	James Cate	....do	....do
Lock No. 1, Barren	William Boulton	July 1, 1878	July 1, 1896

Collections for Green and Barren rivers for year ending June 30, 1895.

Lessees.	Location.	Subject.	Amount collected.
Livers & Welborn	Lock No. 2, Green River	Land and water power	$100.00
James Cate	....do	....do	88.50
Bryant & Nall	....do	....do	150.00
G. D. Hemenway	Lock No. 3, Green River	....do	75.00
William Boulton	Lock No. 1, Barren River	....do	150.00

The leases with Bryant & Nall and G. D. Hemenway are verbal ones made from year to year.

APPROPRIATIONS.

August 11, 1888, for purchase $135,000

ALLOTMENTS.

January 4, 1889	$167,112.00	July 15, 1893	$49,730.88
July 20, 1889	139,110.00	July 13, 1894	25,927.23
July 17, 1890	58,783.47	January 26, 1895	6,000.00
July 16, 1891	77,807.26		
July 15, 1892	46,264.26	Total	565,735.10

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, improved by locks and dams during the fiscal year ending June 30, 1895.

Month.	Lock No. 1, Green River.				Lock No. 2, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.								
July	$234.90	$1,190.71	$24.21	$1,398.92	$324.00	$636.89	$24.21	$985.10
August	186.00	184.60	27.62	400.22	338.00	1,646.82	60.06	2,044.88
September	120.00	704.04	21.77	845.81	235.00	739.84	36.31	1,011.15
October	300.00	1,449.16	19.89	1,769.05	224.50	1.50	18.63	254.63
November	315.00	5,566.05	48.37	5,929.42	145.00	22.55	34.25	201.80
December	175.00	110.25	34.35	319.60	175.00	142.62	34.01	351.63
1895.								
January	120.00	35.60	13.50	169.10	120.00	169.30	18.50	308.80
February	220.00	.....	15.23	235.23	220.00	5.55	15.32	240.87
March	150.00	.....	27.27	177.27	150.00	2.25	27.27	179.52
April	150.60	.....	32.47	182.47	150.00	35.50	32.19	217.69
May	150.00	.....	.....	150.00	150.00	.....	36.62	186.62
June	22.50	.....	4.88	27.38	22.50	.....	4.80	27.30
Total	2,144.50	9,190.41	269.66	11,594.57	2,174.00	3,393.82	337.26	5,905.08

Detailed statement of expenses incurred, etc.—Continued.

Month.	Lock No. 3, Green River.				Lock No. 4, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.								
July	$234.00	$29.75	$24.21	$287.96	$234.00	$40.10	$24.21	$298.31
August	188.00	148.24	23.58	359.82	188.00	139.60	23.58	351.18
September	120.00	4.25	10.08	134.33	120.00	405.20	10.08	535.28
October	260.00	.....	6.61	266.61	260.00	22.20	6.61	288.81
November	190.00	5.45	50.04	245.49	190.00	5.00	34.24	229.24
December	175.00	132.25	34.00	341.25	175.00	37.50	34.00	246.50
1895.								
January	120.00	50.50	21.00	191.50	120.00	30.00	21.00	171.00
February	220.00	38.25	777.51	1,035.76	220.00	.....	15.32	235.32
March	150.00	.....	33.76	183.76	150.00	35.50	27.26	212.76
April	150.00	.....	44.56	194.56	150.00	5.00	39.69	194.69
May	148.33	.....	.....	148.33	150.00	.....	.....	150.00
June	22.50	.....	4.89	27.39	22.50	.....	4.88	27.38
Total	1,977.83	408.69	1,030.24	3,416.76	1,979.50	720.10	240.87	2,940.47

Month.	Lock No. 1, Barren River.				U. S. snag boat Wm. Preston Dixon.				
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries and labor.	Repairs.	Subsistence.	Supplies.	Total.
1894.									
July	$234.00	$21.80	$24.21	$280.01	$816.84	$1,551.37	$270.03	$403.37	$3,041.61
August	188.00	139.60	23.58	351.18	852.50	26.97	266.51	217.10	1,363.08
September	120.00	36.00	10.08	166.08	868.33	.....	190.74	53.70	1,112.27
October	260.00	41.50	6.61	308.11	839.24	32.60	.....	138.30	1,010.24
November	190.00	.....	35.79	225.79	839.00	.....	224.67	266.88	1,330.55
December	175.00	99.00	22.95	296.95	597.35	.....	105.90	107.01	810.26
1895.									
January	120.00	38.48	21.00	179.48	568.18	63.45	60.42	196.75	908.80
February	220.00	4.50	15.32	239.82	435.00	11.00	.....	16.05	462.05
March	150.00	.....	27.26	177.26	435.00	.....	.....	.....	435.00
April	150.00	1.00	39.69	190.69	497.90	161.13	8.70	383.66	1,051.39
May	150.00	35.50	.....	185.50	554.40	.....	.....	.....	554.40
June	22.50	.....	4.88	27.38	.....	.....	.....	.....	.....
Total	1,979.50	417.38	231.37	2,628.25	7,324.34	1,846.52	1,126.97	1,781.82	12,079.65

Month.	U. S. dredge boat Lermond.			
	Salaries and labor.	Repairs.	Supplies.	Total.
1894.				
July	$385.00	$250.18	$57.87	$693.05
August	245.59	2.11	9.60	257.30
September	379.83	31.52	18.47	429.82
October	102.67	.....	17.32	119.99
November	.....	.....	70.20	70.20
December	.....	91.01	22.52	113.53
1895.				
January	111.67	.....	20.00	131.67
February	145.00	11.00	.....	156.00
March	145.00	.....	.....	145.00
April	145.00	.....	101.67	246.67
May	145.00	.....	.....	145.00
June	.....	.....	.....	.....
Total	1,804.76	385.82	317.65	2,508.23

Detailed statement of expenses incurred, etc.—Continued.

SUMMARY.

Green River:	
Lock No. 1	$11,594.57
Lock No. 2	5,905.60
Lock No. 3	3,416.76
Lock No. 4	2,940.47
Barren River, Lock No 1	2,628.25
U. S. snag boat *Wm. Preston Dixon*	12,079.65
U. S. dredge boat *Lermond*	2,508.23
Two new dump scows	1,242.41
Grand total	42,315.42

REPORT OF FIRST LIEUT. JAS. J. MEYLER, CORPS OF ENGINEERS.

BOWLING GREEN, KY., *June 30, 1895.*

MAJOR: I have the honor to submit the following report of operations on Green and Barren rivers, Kentucky, for the fiscal year ending June 30, 1895. The work on these streams is carried on under the indefinite appropriation for operating and care of canals and other works of navigation.

WORK DONE.

LOCK AND DAM NO. 1, GREEN RIVER.

Repairs to dam.—Repaired 205 linear feet of dam; unloaded 1,754 cubic yards of riprap to make a dam above the upper slope; used 1,350 cubic yards of hickory lath sawdust and 25 cords of willow and grass to stop leaks in the riprap dam; hewed face to 2,046 linear feet of crib timber; tore out and removed most of the old sheathing and part of the old crib work in dam proper; laid and spiked 6,112 linear feet of timber and put down 48,636 feet, B. M., of new sheathing; laid 205 linear feet of comb stick, and leveled off riprap dam.

Repairs to lower lock gates.—Rebuilt upper 9 feet of each gate; framed new upper parts on the bank, put them together, and painted them; removed the upper 9 feet of both lower gates and put on the new tops.

New upper gates.—Dressed the timbers for the new gates; built cofferdam above old gates and removed old gates; dressed down both recess walls above upper gates and cut out both upper hollow quoins; put in and completed new upper gates.

General work.—Stopped leaks in unrepaired section of dam by backing same with about 1,000 cubic yards of hickory lath sawdust; repaired lock keepers' dwellings by papering walls and ceilings of both houses; painted both houses on the outside, putting two coats on each house.

LOCK AND DAM NO. 2, GREEN RIVER.

Repairs to upper lock gates.—Rebuilt upper 9 feet of each gate, putting in 6 new arms, 6 new blocks, and a new cap; painted new upper parts. Lower gates: Put in two new arms, 2 new blocks, and new cap in each gate.

General work.—Built crib, 17 by 10 by 14 feet in the race on the Rumsey side of the river; sheathed upper face, filled crib with 88 cubic yards of riprap stone, and filled in above crib with 35 cubic yards of earth and stone; made slight repairs on fuel barge; set four snubbing posts on bank of chute for use of boats during high water; dredged upper and lower entrances to lock; painted one lock keeper's dwelling.

LOCK AND DAM NO. 3, GREEN RIVER.

General work.—Dredged upper entrance; cleaned out well which supplies water for lock keepers' dwellings; papered walls and ceilings of one house; painted both houses.

LOCK AND DAM NO. 4, GREEN RIVER.

Repairs to lower lock gates.—Built upper 12 feet of each gate, putting in 6 new arms, 10 new blocks, and new cap in each gate; painted new upper parts.

General work.—Painted one lock keeper's dwelling; put new caps on upper lock gates.

LOCK AND DAM NO. 1, BARREN RIVER.

General work.—Painted two lock keepers' dwellings; dredged lower entrance to lock; backed dam with 1,090 cubic yards of gravel to stop leaks in same.

U. S. DREDGE BOAT LERMOND.

Lock No. 1, Green River.—Dredged and removed from upper and lower entrances 1,750 cubic yards of mud, 2 snags, 4 saw logs, and 5 pieces of old crib timber.

Lock No. 2, Green River.—Dredged and removed from upper and lower chutes 4,475 cubic yards of material.

Lock No. 3, Green River.—Dredged and removed from upper chute 75 cubic yards of mud and 3 old saw logs.

Lock No. 1, Barren River.—Dredged and removed from lower entrance 200 cubic yards of material.

General work.—Dredged and removed from upper island, at Lock No. 2, Green River, in cutting out an upper entrance to new lock, 20,140 cubic yards of material, 51 stumps, 7 saw logs, 3,087 linear feet of old crib timber, and one old sunken barge, and from lower island, in cutting out new lower entrance, 13,990 cubic yards of sand and earth, 3 saw logs, 274 pieces of timber, and 1,480 linear feet of old cribbing; dredged and loaded on barge 1,090 cubic yards of gravel to be used for backing dam at No. 1, Barren River; dredged and removed from the channel of Barren River, between the lock and Bowling Green, as follows: At Robinsons Island, 1,350 cubic yards of material; at Stevens Island, 350 cubic yards of material; at Cow Ford, 1,350 cubic yards of material; at Big Eddy, 225 cubic yards of material; at Boat Island, 1,325 cubic yards of material; at point of Underwood Island, 850 cubic yards of material. Dredged and loaded on barge at No. 1, Barren River, 100 cubic yards of gravel, to be taken to No. 2, Green River. Made all necessary repairs to machinery.

U. S. SNAG BOAT WM. PRESTON DIXON.

Removed 2,005 snags, weighing 3,030 tons, from channel of river; cut on shore 214 overhanging trees; deadened on shore 250 overhanging trees; loaded on barge at Wrightsburg and towed to No. 1, Green River, to back dam and stop leaks in same, about 1,000 cubic yards of hickory lathe sawdust, and to stop leaks in riprap dam used in repairing dam about 1,350 cubic yards of the same sawdust; did all necessary towing on Green and Barren rivers. Total miles run, 6,020.

GENERAL WORK.

Made extensive repairs on two deck barges and two derrick boats as follows:

Two barges.—Removed old decks, gunwale stays, timber heads, and rake frames, and put in new ones; calked and paid seams and painted hulls above water line.

Two derrick boats.—Removed old decks, gunwale stays, and rake frames, and put in new ones; removed old derricks and put in new ones; calked and paid seams and painted hulls above water line.

Removed 32 linear feet of comb stick of dam at No. 2, Green River, so as to haul dredge out over the crest and repair rakes and put on new comb stick.

Building two dump scows.—Framed and put together all timbers for both scows; set in all braces for pockets and hulls; calked bottoms, rakes, and part of gunwale seams of sides of each boat; made doors and hinges for one scow, and all driftbolts, tie-rods, and bolts for use on both scows; launched one scow. Both scows are but partly completed.

Respectfully submitted.

JAMES J. MEYLER,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers.

Commercial statistics of Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1895.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barrels, empty	55	52	1,268	650	65	27
Beer	1,245	222	92	61	56	58
Cement	168	600	83	37	304	174
Coal	45,904	49,000	71,431	70,060	46,488	37,848
Flour	773	1,363	1,540	1,813	1,930	2,206
Grain	1,421	1,284	2,956	3,454	2,931	1,987
Handles	227	6,144	605	286	396	291
Hay	319	427	1,106	439	655	740
Hides	19	30	233	48	61	45
Hoop poles	278	770	4,342	1,329	789	1,095
Iron, manufactured	98	253	186	4	26	9
Live stock	482	1,285	2,056	2,658	2,284	2,226
Lumber	2,866	9,000	14,505	14,548	11,197	16,903
Merchandise	8,933	16,420	13,093	9,992	18,711	9,764
Produce	501	184	384	242	193	165
Salt	1,014	1,104	1,376	1,331	1,012	1,148
Stone	788	14,752	10,742	4,202	22,723	16,783
Staves and heading	.....	744	7,841	9,067	9,027	7,609
Ties, railroad	16,373	21,325	40,736	24,684	63,069	84,351
Tobacco, leaf	4,723	2,164	1,858	2,164	3,385	1,644
Timber, logs, etc	819,920	500,000	283,911	465,858	334,483	158,494
Whisky	57	43	51	54	37	28
Passengers	972	1,434	1,813	1,392	1,291	1,188
Total	907,146	628,600	462,208	614,378	521,115	344,833

Lists of boats plying on Green and Barren rivers, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Evansville	Passenger	121	30	5	194.25
J. C. Kerr	do	120	21	3.7	121.15
H. D. Munson	do	121	22	4	149.80
Gayoso	do	127.3	30	6	197.99
Mary Stewart	do	100	20.6	3.6	90.29
Ed. J. Wood	do	80	12	4	32.97
Lela	do	70	18	3	62.27
T. C. Woodward	do	65	9	4	33.50
City of Clarksville	do	125	24.5	3.5	194.60
Verne Swain	do	122	22.6	5	134.76
Ashland City	do	120	20	3.9	94.55
City of Chartiers	Towboat	120.7	20.1	2.9	113.63
Longfellow	do	112	19.6	4.3	93.58
D. A. Nisbet	do	105	20	3.6	64.68
I. N. Hook	do	109	19.4	3	55.95
Little Clyde	do	100	20	3.6	52.20
Stoneware	do	100	17	3	63.19
Troubadour	do	93.4	18	3	61.37
Little Tom Moss	do	90	22	3	56.30
John T. Carson	do	85	18.8	3	47.60
Little Albert	do	64.5	19.9	2.9	34.52
Eleanor	do	60	16	2.8	14.64
Ida	do	60	14	3	22
Racket	do	99	16.2	3.6	52.84
J. B. Horton	do	65	14	4	36
Herbert Moran	Tugboat	94	16	6	51.98
Blanche	do	87	16	4.6	48.40
Ingleside	do	81	14	4	36
Isabella	do	95	22	4.8	66.24
Louise	do	73	16.5	3.8	40.80
Orphan Girl	do	80	15	4	39
Mattie	do	56	8.1	3.8	12.33
Lena Archer	do	45	9	4	8
Lumberman	Sawmill boat	119	24.2	4.2	111.82
Wm. Preston Dixon	U. S. snag boat	124.9	32	5	200

Report of lockages on Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1895.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1, Green	291	74	395	309	135	394	297	240	129	1,899	2,149
No. 2, Green	339	26	328	251	26	324	243	152	20	1,344	1,606
No. 3, Green	349	16	360	233	104	351	223	123	108	1,502	1,663
No. 4, Green	355	10	436	238	52	430	233	54	64	1,507	1,557
No. 1, Barren	355	10	312	169	21	306	166	32	35	1,041	1,041
Total	1,689	136	1,831	1,200	338	1,805	1,162	601	356	7,293	8,016

NOTE.—Locking through No. 1, Green River, was suspended 22 days for repairs, 40 days for high water, and 12 days for ice; through No. 2, Green River, 12 days for high water and 14 days for ice; through No. 3, Green River, 16 days for ice; through No. 4, Green River, and No. 1, Barren River, 10 days each for ice.

G G 5.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

Rough River is a tributary of Green River, emptying into it at a point 71 miles from its mouth and 8 miles above Lock No. 2, at Rumsey.

Shortly after the war a company built a timber and stone lock, with dam and abutment, about 8 miles from the mouth of the river, and steamboats from 110 to 125 feet long ran up the river as far as Hartford, until the Green and Barren rivers improvements were leased to the Green and Barren Rivers Navigation Company by the State of Kentucky. It is claimed that the excessive tolls charged by the navigation company effectually killed the commerce of Rough River, and the lock and dam were abandoned. The dam was only 90 feet long, and shortly afterwards the river cut around the abutment.

Eventually the dam was torn out so that now nothing but the ruins of the old lock remain.

The river was much obstructed at the time work on it was commenced, and, being narrow and very crooked, some of the bends were almost filled with snags, sunken timber, and logs, while overhanging trees on the banks constituted a still further obstruction to steamboats.

The project for this improvement was approved October 27, 1890, and provides as follows: First, to definitely locate the site of the lock proposed and purchase or have condemned the land needed about the lock and abutment; second, clear the river of obstructions, to wit, overhanging trees on the banks, and snags, logs, and stumps in the bed of the river. The estimate for this was $300 per mile, or $9,000 for the 30 miles between the mouth of the river and Hartford.

The river has been gone over from its mouth to Hartford, trees on the banks deadened, and snags and logs removed from the bed of the stream. As far up as the site of the lock the river is now navigable, and the snag boat *Wm. Preston Dixon* has made the trip several times. Thirty-one thousand trees have been deadened, 9,901 tree tops cut up, 4,227 leaning trees cut down and cut into short lengths, and 6,224 snags and logs removed from the bed of the river.

The original project called for a masonry lock, but on account of the difficulties connected with the delivery of stone, the bids received for furnishing it were so high that it was deemed advisable to substitute concrete of imported Portland cement for the stone, and project and plans to carry out this method of construction were prepared and submitted, under date of January 23, 1895, to the Chief of Engineers for his approval, which was given under date of January 28, 1895.

The work done to the end of the fiscal year has been in preparing site, obtaining material and plant, and setting up the latter. The U. S. dredge boat *Lermond* has been employed in clearing up the channel of the river near the lock and in excavating the site for cofferdam. The necessary buildings for storage of material, blacksmith shop and office, and the trestles and track to be used are about completed.

The deadened trees on banks in upper part of river, above lock, will have to be cut down before the dam is put in and the logs and snags removed from the bed of the river.

Assistant Engineer William M. Hall is in immediate charge of the work, and for details of work attention is invited to his report herewith.

APPROPRIATIONS.

September 19, 1890	$25,000
July 13, 1892	15,000
August 17, 1894	22,500
Total	62,500

Money statement.

July 1, 1894, balance unexpended	$32,509.72
Amount appropriated by act of August 17, 1894	22,500.00
	55,009.72
June 30, 1895, amount expended during fiscal year	5,005.20
July 1, 1895, balance unexpended	50,004.52
July 1, 1895, outstanding liabilities	11,248.04
July 1, 1895, balance available	38,756.48
Amount (estimated) required for completion of existing project	43,056.05
Amount that can be profitably expended in fiscal year ending June 30, 1897	43,056.05
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. WM. M. HALL, ASSISTANT ENGINEER.

LIVERMORE, KY., *June 30, 1895*

MAJOR: I have the honor to submit the following report of work on Rough River Lock for the fiscal year ending June 30, 1895:

In September, 1894, I made a hydrographic survey of Rough River at the lock site and immediately above and below same. In doing this work soundings were made both to river bed and to top of sandstone ledge, a few feet below, at intervals of 50 feet along stream for a distance of about 1,200 feet. In so doing it was found that the top of ledge is from about 3 feet 10 inches to 7 feet 6 inches below the low-water line. In order to determine the lift at lock necessary to put 4 feet of water over the sand bar at Hartford, a line of levels was run during the same month and checked by a second running from lock site to Hartford, about 23 miles upstream. These two lines of levels were connected with levels formerly run from Lock No. 2, Green River, Kentucky, to lock site on Rough River.

On account of the fact that no suitable stone for cut-stone masonry is to be found near the lock site, the most available being in Indiana, which would require more than 100 miles transportation, and the fact that excellent gravel and limestone suitable for concrete are found nearer the lock site, and the further fact that estimates for

both cut-stone and concrete masonry indicated that the lock and abutment could be built of the latter at a less cost than of the former, it was deemed advisable to construct of concrete. With this end in view, I prepared plans for a concrete lock and abutment, plan of forms for erecting concrete walls, and all other necessary plans for use in executing the work. I also prepared detailed estimates of cost of work, and prepared bills of material, machinery, tools, etc., necessary for use in construction, and also prepared the specifications required for the purchase of same.

The lock walls are designed to be 189 feet 3 inches long, 24 feet high, at ends 12 feet thick at base and 10 feet at top, and along chamber 12 feet thick at base and 5 feet thick at top. The chamber of lock is designed to be 27 feet wide and 145 feet 9 inches between quoins.

As the money available for work during the season of 1895 is insufficient for the entire lock and abutment, it is possible to do only a part of the construction this season. It has therefore been deemed best to build the river (or outside) wall of the lock and the abutment with the money at hand. With this end in view, during April and May last contracts were let for the purchase of all the machinery, tools, and other plant necessary for conducting the work, and for timber and iron necessary for cofferdam and concrete forms, and for the cement, sand, gravel, and broken stone necessary for use in construction of one lock wall and the abutment. The quantities of these materials are as follows:

Iron	pounds..	12,000
Gum timber for cofferdams	feet, B. M..	63,000
Yellow pine for concrete forms	do....	144,000
Portland cement	barrels..	3,300
Sand	yards..	1,100
Broken stone	do....	1,700
Gravel	do....	700

On April 29 actual work of construction was commenced with a small force, and has continued to this date. However, on two occasions it has been nearly brought to a standstill by reason of contractors failing to deliver materials and machinery on time.

At this date we have received nearly all the tools and small supplies contracted for, and nearly all the lumber, timber, and iron for temporary buildings and trestles. We have received 2 hoisting engines, 1 feed pump for boilers, the fixtures for 2 derricks, 1 10-inch centrifugal pump, 19 tons of steel rail for temporary tracks, about 25,000 feet, B. M., of gum timber for cofferdam, about 140,000 feet, B. M., of yellow pine for concrete forms, 184 yards of sand, 252 yards of gravel, 100 yards of broken stone, and about 12,000 pounds of iron for cofferdam and concrete forms.

The excavation required for the lock is estimated at 5,000 yards above water and 4,500 yards below water. On the 17th of June the excavation above water was commenced, and 586 yards has been excavated to date.

When work was commenced here the river had a large number of logs and snags in it, extending from its mouth to the lock site. In May the U. S. snag boat *Wm. Preston Dixon* removed these obstructions. The snag boat worked on the channel between the mouth of the river and the lock site for nine days, and accomplished the following work:

Snags removed	226
Overhanging trees cut	6
Trees deadened	4

The cost of this work by the snag boat was about $400 for labor and supplies.

At about 1,000 feet below the lock site there was, years ago, a mill dam, which when we commenced work here had not been entirely destroyed. This dam and the destruction of the old timber lock and dam about 150 feet above the site of new lock caused a large collection of drift, timber, and mud in the river bed, from the new lock site to the old dam. In order to deliver material for the construction at site of new lock during low water, it was necessary to have this old dam and accumulation of drift and timber removed. For this purpose and for the purpose of making the excavation of lock pit below water, the U. S. dredge boat *Lermond* was furnished me on June 12. It has worked since on the excavation of channel, which has been put in a satisfactory condition for the delivery of material, and has just commenced on the excavation of lock pit. The work done by the dredge boat is as follows:

Days worked		16
Excavated in channel below lock	cubic yards..	3,160
Snags removed from channel		232
Excavated from approach to lock pit	cubic yards..	580
Snags removed from approach to lock pit		83
Total cost of labor for this work		$243.83

On June 10 the steamer *Mary Stewart* was furnished me for carrying supplies and materials from Livermore to the lock site, 7 miles, and for towing away and dumping dredged material. Since that date it has worked seventeen days, and the work done is as follows: Carried from Livermore to lock site 81,000 pounds of machinery, supplies, etc.; towed to lock site from Rumsey, 15 miles, U. S. dredge boat *Lermond* and two 120-foot dump scows; towed from dredge boat from one-half to three-fourths of a mile, and dumped, 80 scows containing about 2,400 cubic yards of excavated material and 183 snags. The cost of this work by the *Mary Stewart* was $340.

We are now in condition to vigorously prosecute this work until that proposed for the season of 1895 is completed.

Respectfully submitted.

WM. M. HALL, *Assistant Engineer.*

Maj. D. W. LOCKWOOD,
Corps of Engineers.

Commercial statistics of Rough River, Kentucky, for fiscal year ending June 30, 1895.

Articles.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Logs	89,161				
Lumber	9,000				
Timber, logs, etc		50,000	75,000	64,401	36,945
Total	98,161	50,000	75,000	64,401	36,945

List of boats plying on Rough River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Mary Stewart	Passenger	100	20½	3½	90.20
Little Tom Moss	Towboat	90	22	3	56.30
Ida	do	60	14	3	22
Lela	Passenger	70	18	3	63.27
Stoneware	Towboat	100	17	3	53.19

GG 6.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River is a tributary of the Ohio, and empties into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of the river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky and extend slack-water navigation for a draft of 6 feet by the construction of additional locks and dams to Beattyville, a distance of 261 miles from the mouth of the river.

In pursuance of the foregoing, Lock No. 6, 15 miles above Lock No. 5—the upper lock built by the State of Kentucky—has been completed, carrying 6 feet of slack water to High Bridge.

LOCK NO. 7.

The location of this proposed lock is a short distance below High Bridge, on what is known as Cow Shoal. There is deep water up to this locality, while a short distance above is a shoal with about 5 feet depth at pool stage. Above, to what was formally the old location of No. 7, there are several places where there is only about 5 feet or less.

The old locks on the Kentucky River were located on the heads of ripples, and as a result during low-water seasons, when the water in the pools gets below the crests of the dams, considerable dredging is necessary to carry a navigable depth up to the locks. For this reason it was deemed advisable to locate No. 7 where it now is, particularly as this location possesses many advantages over others considered. The question of obtaining title to land required has been in the courts for some time, and I understand that the matter has just been decided, although I am not aware that the decision has been formally promulgated.

During the past year levels have been run from the head of the proposed pool of No. 7 to No. 6, and as this record is valuable it is embodied in the report of Capt. H. E. Waterman, Corps of Engineers.

At Lock No. 6 the lock tenders' dwellings have been finished and certain other work done, completing the lock.

For details attention is invited to report of Capt. H. E. Waterman, Corps of Engineers, herewith.

APPROPRIATIONS.

March 3, 1879	$100,000	July 13, 1892	$150,000
June 14, 1880	100,000	August 17, 1894	125,000
March 3, 1881	125,000		
August 3, 1882	225,000	Total	1,622,500
July 5, 1884	250,000	Received from Taber & Cogar, October, 1888	500
August 5, 1886	187,500		
August 11, 1888	180,000		
September 19, 1890	180,000		1,623,000

Money statement.

July 1, 1894, balance unexpended	$66,878.22
Amount appropriated by act of August 17, 1894	125,000.00
	191,878.22
June 30, 1895, amount expended during fiscal year	7,319.62
July 1, 1895, balance unexpended	184,558.60
July 1, 1895, outstanding liabilities	1,528.32
July 1, 1895, balance available	183,030.28
Amount (estimated) required for completion of existing project	1,399,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

NOTE.—For list of boats plying the Kentucky River, and for commercial statistics for Kentucky River, see report for operating and care of canals, etc., as applied to Kentucky River.

REPORT OF CAPT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1895.

MAJOR: During the past fiscal year the lock grounds and two lock houses at No. 6, have been completed. Nothing more will be needed at this lock except an allotment for maintenance, under the permanent appropriation for operating and care of canals and the maintaining and preserving of navigation as applied to Kentucky River.

During the low-water season of last year a careful level line was run from the site of Lock No. 7, near Cow Shoal, Kentucky River, up the river as far as the slack

water from the proposed new dam would extend. This was also connected with the upper gauge at Lock No. 6 by another level line. The survey extended to a distance 11.5 miles above Hickman Bridge. Dam No. 7 will give a 6-foot stage at low water for about a mile above this bridge. Pool No. 6 will then be about 20 miles long, and Pool No. 7, 19 miles.

The description of the bench marks established on these surveys is as follows:

Bench marks between bridge at Hickman and Lock No. 6, Kentucky River, Kentucky.

NOTE.—These bench marks were established in July, 1894, by G. F. Stickney, assistant engineer. They are all plainly visible from the river, and are marked with black paint, using letters from 8 to 12 inches high. Each bench mark is marked with its number, and they are numbered consecutively from the bridge at Hickman down to Lock No. 6. The elevations are referred to the plane of low water at the mouth of the Kentucky River, assuming that the zero of the upper gauge at Lock No. 6 is 82.620 feet above this plane.

No.	Elevation.	Below Hickman Bridge.	Above Lock No. 6.	Description.
	Feet.	*Miles.*	*Miles.*	
1	112.582	.....	38	On iron pin set in west side of south abutment of bridge at Hickman on left bank of river.
2	106.819	1	37	On copper nail in root of beech tree, blazed, on right bank of river.
3	107.081	1⅛	36⅛	On step cut in ledge of rock on right bank of river at White Oak Shoal.
4	107.462	3	35	On cross mark on ledge of rock on left bank of river, between two sycamore trees, blazed, ¼ mile below Little Shoal.
5	107.012	4	34	On highest point of big flat rock on left bank of river 800 feet below Buzzards Island.
6	114.224	5	33	On raised mark cut on big rock on right bank of river.
7	110.318	6	32	On copper nail on east side of big sycamore tree, blazed, on right bank of river.
8	112.190	7	31	On copper nail on south side of big sycamore tree, blazed, on right bank of river, house on left bank 300 yards above; 3,000 feet above Steels Dam.
9	107.843	8	30	On raised mark on ledge of rock on left bank of river 2,000 feet below Steels Dam.
10	107.591	9	29	On copper nail in big sycamore tree, blazed, on right bank of river 1⅞ miles below Steels Dam.
11	110.077	10	28	On raised mark on ledge of rock on left bank of river 2⅞ miles below Steels Dam.
12	111.086	11	27	On copper nail in south side of big sycamore tree, blazed, on left bank of river 3⅞ miles below Steels Dam.
13	111.928	12	26	On copper nail in south side of big leaning sycamore tree, blazed, on left bank of river 4⅞ miles below Steels Dam.
14	110.680	13	25	On copper nail in west side of maple tree, blazed, on left bank of river; big sycamore, blazed, to left; 8¾ miles above High Bridge.
15	108.833	14	24	On copper nail in south side of elm tree, blazed on left bank of river 2¾ miles above High Bridge.
16	108.947	15	23	On copper nail in maple tree, blazed, on left bank, opposite house on right bank, 1¾ miles above High Bridge.
17	108.115	16	22	On raised mark on big rock on left bank 20 feet below spring; opposite rock crusher of Cincinnati, New Orleans and Texas Pacific Railway, ¾ mile above High Bridge.
18	109.421	17	21	On raised mark on ledge of rock on right bank 1,400 feet below High Bridge, 600 feet above ferry landing.
19	98.030	18	20	On copper nail in maple tree, blazed, on right bank 1¾ miles below High Bridge.
20	97.929	19	19	On copper nail in stump, blazed, on edge of cornfield on right bank 2¾ miles below High Bridge.
21	101.531	20	18	On copper nail in big lone sycamore tree, blazed, on left bank opposite water course in face of cliff on right bank 3¾ miles below High Bridge, 1⅞ miles above Brooklyn Bridge.
22	100.110	21	17	On raised mark on right bank 2,110 feet above Brooklyn Bridge.
23	98.710	22	16	On copper nail in maple tree, blazed, on left bank 3,200 feet below Brooklyn Bridge.
24	102.244	23	15	On copper nail in hackberry tree, blazed, on right bank 600 feet below ferry, 1⅞ miles below Brooklyn Bridge.
25	95.438	24	14	On raised mark on large rock on left bank 2⅞ miles below Brooklyn Bridge, 1¼ miles above Mundys Landing, 100 feet below house on right bank.
26	98.503	25	13	On raised mark on ledge of rock on left bank at salt spring ¼ mile above Mundys Landing.
27	99.546	26	12	On copper nail in sycamore tree, blazed, on right bank ¼ mile below Mundys Landing, opposite house on left bank.
28	96.073	27	11	On copper nail in maple tree, blazed, on right bank of river 1¼ miles below Mundys Landing.
29	97.881	28	10	On copper nail in sycamore tree, blazed, on right bank 2¼ miles below Mundys Landing.
30	99.405	29	9	On notch cut in cliff on right bank 3¼ miles below Mundys Landing, 400 feet above waterfall.
31	98.294	30	8	On copper nail in sycamore tree, blazed, on right bank 4¼ miles below Mundys Landing.

Bench marks between bridge at Hickman and Lock No. 6, etc.—Continued.

No.	Elevation.	Below Hickman Bridge.	Above Lock No. 6.	Description.
	Feet.	*Miles.*	*Miles.*	
32	97.743	31	7	On copper nail in elm tree, blazed, on right bank 5½ miles below Mundys Landing, opposite house on left bank.
33	99.243	32	6	On copper nail in walnut tree, blazed, on right bank of river 6½ miles below Mundys Landing, 5 miles above Oregon Ferry.
34	95.732	33	5	On raised mark on stone on left bank, about center of big bend; two houses on right bank nearly opposite; 4 miles above Oregon Ferry.
35	96.296	34	4	On copper nail in big sycamore tree, blazed, on left bank 3 miles above Oregon Ferry; house on right bank about 300 yards above.
36	98.904	35	3	On copper nail in sycamore tree, blazed, on right bank 2 miles above Oregon Ferry.
37	97.062	36	2	On raised mark on big rock on right bank 1 mile above Oregon Ferry.
38	95.366	37	1	On raised mark on stone on right bank 280 feet above ferry landing, opposite Oregon.
39	95.620	38	0	On 13-foot mark, upper gauge, Lock No. 6.

Bench marks on the Kentucky River above Hickman.

NOTE.—These bench marks were established by G. F. Stickney, assistant engineer, in December, 1894, in the same manner as the preceding bench marks, and are numbered consecutively from the starting point down to the bridge at Hickman, Ky.

No.	Elevation.	Above Hickman Bridge.	Description.
	Feet.	*Miles.*	
40	126.198	11.5	On iron pin set in ledge of rock on right bank, 4 feet to right and 6 feet below elm tree, blazed, 3,050 feet above ferry landing on right bank at Paint Lick, Ky.
41	122.434	10.6	On copper nail in big sycamore tree, blazed, on right bank, 1,530 feet below ferry landing on right bank at Paint Lick.
42	120.233	9.6	On iron pin set in ledge of rock on right bank 26 feet below sycamore tree, blazed, 1½ miles below ferry landing at Paint Lick, 2½ miles above ferry landing at Sugar Creek.
43	119.748	8.6	On copper nail in big lone sycamore tree, blazed, on right bank of river 2½ miles below ferry landing at Paint Lick, 1½ miles above ferry landing at Sugar Creek.
44	123.513	7.6	On copper nail on big sycamore tree, blazed, on right bank of river 3½ miles below ferry landing at Paint Lick, ½ mile above ferry landing at Sugar Creek.
45	118.606	6.6	On copper nail in big sycamore tree, blazed, on right bank 2,500 feet below ferry landing at Sugar Creek.
46	116.559	5.6	On copper nail in small sycamore tree, blazed, on right bank 800 feet above Snapping Branch, 1½ miles below ferry landing at Sugar Creek.
47	113.891	4.6	On copper nail in big sycamore tree, blazed, on right bank of river 3,600 feet below Hogans Branch, 2 miles above Canoe Creek Shoal.
48	115.234	3.6	On copper nail in elm tree, blazed, on right bank 1.7 miles below Hogans Branch, 1 mile above Canoe Creek Shoal.
49	109.685	2.6	On copper nail in big sycamore tree, blazed, on right bank at lower end of Canoe Creek Shoal.
50	110.178	1.6	On copper nail in big maple tree, blazed, on right bank 1 mile below Canoe Creek Shoal, 0.6 mile above Little Hickman Shoal.
51	108.200	.6	On raised mark on big rock on left bank 0.3 mile below Little Hickman Shoal, 3,375 feet above bridge at Hickman, Ky.

A large part of the Kentucky River is confined between high hills on both sides, and bottom lands are very limited and of slight value. It is thought, therefore, that the objections to high dams, on account of flooding of abutting property, have here little weight, and but little increased height will be needed for the lock wall, as navigation is generally suspended during the extreme high stages. By increasing the lift of the dams above 15 feet it might be possible to save one lock and dam in completing the project from Cow Shoal to Beattyville, Ky. As a test of the stability of such dams, it may be stated that Dam No. 6 has stood with a head of some 19 feet while repairs were in progress below, and with little evidence of leakage.

Last October the old U. S. snag boat *Kentucky*, which had already been condemned, was sold at public auction.

The U. S. S. *Gen. O. M. Poe*, which has replaced the *Kentucky*, has performed a large amount of useful work.

Proceedings have been begun in the United States court, and partly carried through, for the condemnation of the land and roadway needed for the proposed Lock No. 7 at Cow Shoal.

Two new flats are now being built to replace some of the present fleet in bad condition.

The following is a detailed statement of the work for the past year:

LOCK NO. 6.

Upper lock house.—Finished weatherboarding; put on frieze, cornice, and cornice brackets; finished shingling roof, and put on saddle boards; shingled roof of and laid floor on porch; built latticework under same; cut down door frames; stripped out studding to receive strips for wainscoting; wainscoted two rooms; built stairway; put in partition and door frames; built and placed in position three pairs of outside doorsteps; fit and hung windows in frames; built gable across end of porch, and put brackets and scrolls on same; put in all doors, windows, and inside casings; capped wainscoting; put on base and quarter-round molding; put scotia on stairway; built and shelved closets; fit, hung, and put locks on all doors, and catches on windows; fit and hung mullion window; put in carpet strips; built and put in position cellar steps; lathed and plastered house; puttied up all nail holes on inside of house; painted outside two coats and inside three coats; gave roof two coats of creosote stain; laid hearths, hung mantels, and set grates, completing new house.

Lower lock house—Wainscoted two rooms and put cap on wainscoting; shingled roof and laid floor on porch; built latticework under porch; built partitions and framed closets; put up three pairs of outside steps; fit and hung all windows and put catches on same; fit and hung all doors and put locks on same; built gable across end of porch and put up brackets and scrolls; fit and put up mullion window; built and shelved all closets; puttied nail holes on inside of house; lathed and plastered house; painted outside of house two coats and inside three coats; gave roof two coats of creosote stain; laid hearths, hung mantels and set grates; put terra-cotta drain in cellar, completing the house.

General work—Wheeled 35 cubic yards of sand from barge to top of slope fill for making mortar; removed 2 cubic yards of sand from cellar in leveling same; mixed mortar; removed rubbish from houses and grounds. Watched and cared for boats, barges, and other Government property. Repaired lock gates.

LOCK NO. 4.

Construction of two new barges: Received and stacked timber for the construction of two new barges; outganged bottom plank; dressed and sized gunwales; dressed and framed head blocks; cut scarfs on gunwales and streamers; pointed drift bolts; built cribs to set barges on; moved timber from shed to place of construction; set up timbers and bolted and spiked same; laid decking; painted timbers; calked one barge and part of the second barge; completed and launched one barge on June 27, 1895.

LOCK NO. 7.

Organized and equipped surveying party for running line of levels from Hickman, Ky., to Lock No. 6; worked up river to near Hickman with quarter boat; ran line of levels from Hickman, Ky., to Lock No. 6; established bench marks at end of each mile; took soundings in the river at the end of every 1,000 feet from Hickman down to the proposed site of Lock No. 7; made profile map of the river from Hickman to Lock No. 6; ran line of levels, with soundings, from Hickman, Ky., 11¾ miles up the river, and established permanent bench marks; made profile map of the river bed; made survey of the right of way from the turnpike to proposed site of Lock and Dam No. 7.

BEATTYVILLE DAM.

No operations were undertaken during the year aside from caring for Government property.

ROCK SHOAL QUARRY.

No operations were undertaken during the year aside from caring for Government property.

Respectfully submitted.

H. E. WATERMAN,
Captain of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers.

Commercial statistics of Kentucky River, Kentucky, for fiscal year ending June 30, 1895.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Beer	.....	.....	345	325	193	52
Brick	.....	.....	130	771	1,394	156
Coal	89.562	89.752	203,224	177,083	108,169	49,912
Cement	.....	.....	200	1,116	1,919	333
Cooperage	.....	.....	736	889	670	.....
Cross-ties	.....	.....	1,445	725	.....	.....
Grain	6,991	14,279	10,219	12,094	7,859	4,344
Flour	1,503	1,744	6,233	5,120	6,407	1,719
Hay	4,407	500	6,488	5,671	2,273	2,620
Iron	1,903	712	4 292	493	175	.....
Live stock	2,350	3,065	2,506	2,071	2,288	838
Logs	158,903	224,844	72,749	63,197	68,866	206,342
Lumber	10.670	15.256	13,336	13,084	.....	3,170
Merchandise, miscellaneous	19 554	21,739	60.618	28,156	25,744	13,810
Salt	909	1,602	9,025	4.276	3,328	654
Timber	4.682	3,761	21,831	3,131	3,078	.....
Tobacco	2.783	5,636	11,199	5,808	11,667	4,468
Whisky	4,142	4,306	4,098	3,263	3,732	5,059
Passengers	1,995	2,023	3,172	3,176	3,055	2,841
Total	310,354	389,219	431,846	330,449	250,817	296,318

G G 7.

OPERATING AND KEEPING IN REPAIR THE SIX LOCKS AND DAMS ON KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of these locks and dams in 1880, at which date they were in a more or less crippled condition, the timber of the dams being badly decayed and the lock gates and operating machinery in such a state as to need absolute removal or extensive repairs.

Some of the dams have been entirely rebuilt, the others nearly so. Guide walls above and below the locks have been constructed, and the banks about the locks and abutments protected by timber cribbing to prevent erosion.

New lock keepers' houses have been built, the areas in rear of land walls graded and paved, and the grounds graded, sown with grass seed, and fenced.

With the completion of Lock and Dam No. 6, slack-water navigation was extended to High Bridge, which is 121 miles above the mouth of the Kentucky.

During the past year general repairs have been made to the dams, such as replacing sheeting, and backing those found to be leaking with gravel and riprap.

The upper slopes of dams Nos. 2 and 3 were entirely resheeted. New lower gates were put in at No. 3, and new upper gates for Nos. 2 and 4 are now in process of construction. Two new barges are about completed. Leestown Bar, below No. 4, and Clear Creek Shoal, 1 mile below Lock No. 6, have been dredged.

In November, 1881, a washout around the abutment at No. 1 occurred. The fill required to close the break was made with any material obtainable, and this material has been settling by compression ever since. The end of the dam next the abutment was built on sand and mud originally after the old arm, which made an angle with the section next the lock, had been washed out. As a result there have always been leaks about the abutment and its end of the dam. My plan has hitherto been to throw in riprap in the upper angle between dam and abut-

ment, and this plan has worked very well, although the end of the dam is down about 10 inches. The entire dam now requires backing, and the front, from the crest forward, needs extensive repairs.

In last year's estimate provision was made for raising the upper miter wall at Lock No. 4, the upper 3 feet of which is composed of timber. This work it is proposed to do at once. Eventually the same should be done at Locks 1, 2, and 5; the change has been made at No. 3, and the result is very satisfactory.

Although the five old locks built by the State were on rock foundations the lower miter walls were constructed of timber, a trussed mud sill being used. As this timber becomes weakened by rocks, abrasion, and natural deterioration, leaks manifest themselves which are difficult to stop, and the gates get out of shape from the displacement of the pintles on their wooden supports.

These old wooden miter walls should all be rebuilt of masonry.

For details of work done during the past year attention is invited to the report of Capt. H. E. Waterman, Corps of Engineers, herewith.

Kentucky River, Kentucky, leases for year ending June 30, 1895.

Location.	Lessee.	Dated.	Expires.
Lock No. 4	Kentucky River Mills	July 10, 1878	July 10, 1977

This lease was made by the Commonwealth of Kentucky.

Collections for Kentucky River, Kentucky, for year ending June 30, 1895.

Lessee.	Subject.	Amount collected.
Kentucky River Mills	Land and water power	$180

Allotments for fiscal year ending June 30.

1885	$15,000.00	1892	$48,826.68
1886	24,000.00	1893	40,503.62
1887	35,133.60	1894	73,065.02
1888	82,308.54	1895	46,435.28
1889	82,478.50		
1890	72,394.80	Total	549,035.11
1891	28,889.07		

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1895.

Month.	Lock No. 1.				Lock No. 2.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.								
July	$234.99	$99.59	$23.01	$357.59	$235.00	$121.43	$28.38	$384.81
August	199.17	76.39	7.50	283.06	199.18	7.74	.....	206.92
September	140.84	18.60	4.76	164.20	140.84	35.59	4.51	180.94
October	261.68	.....	2.00	263.68	261.68	.....	2.00	263.68
November	203.34	1.50	7.36	212.20	203.34	1,257.17	14.53	1,475.04
December	183.50	7.59	8.62	199.71	215.83	.....	8.62	224.45
1895.								
January	235.00	1.65	6.00	242.65	203.33	1.65	.....	204.98
February	203.34	6.50	17.44	227.28	203.34	.....	17.44	220.78
March	145.00	.....	34.57	179.57	145.00	.....	14.11	159.11
April	223.32	51.25	1.86	276.43	223.33	286.34	1.86	511.53
May	211.67	1.33	.....	213.00	211.66	.....	.....	211.66
June	27.08	.....	.....	27.08	27.08	.....	.....	27.08
Total	2,268.93	264.40	113.12	2,646.45	2,269.61	1,709.92	91.45	4,070.98

Detailed statement of expenses incurred, etc.—Continued.

Month.	Lock No. 3.				Lock No. 4.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.								
July	$235.01	$98.52	$19.46	$352.99	$235.00	$166.32	$19.46	$420.78
August	210.67	286.80	.....	497.47	199.16	38.57	.....	237.73
September	140.88	1,094.73	18.76	1,254.32	140.83	39.58	3.81	184.22
October	261.66	379.67	6.25	647.58	261.66	165.03	2.00	428.69
November	203.33	68.92	7.92	280.17	203.33	32.74	7.34	243.41
December	215.83	.....	8.62	224.45	215.83	199.06	8.62	423.51
1895.								
January	203.33	1.65	.....	204.98	203.33	79.29	.....	282.62
February	203.33	.75	17.43	221.51	203.33	118.87	17.43	339.63
March	145.00	.....	14.22	159.22	145.00	34.22	14.42	193.64
April	223.34	.....	3.53	226.87	223.34	289.96	1.87	515.17
May	211.67	.....	.....	211.67	211.66	15.50	.....	227.16
June	27.08	.....	.....	27.08	27.08	.....	.....	27.08
Total	2,281.08	1,931.04	96.19	4,308.31	2,269.55	1,179.14	74.95	3,523.64

Month.	Lock No. 5.				Lock No. 6.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.								
July	$235.00	$90.00	$19.46	$344.46	$185.00	$118.06	$38.29	$341.35
August	199.16	176.25	.....	375.41	149.16	18.70	.....	167.86
September	140.83	30.95	3.81	175.59	90.83	113.06	14.10	217.99
October	261.66	.....	2.40	264.06	211.66	100.06	2.40	314.12
November	203.33	684.02	12.34	899.69	153.33	132.42	7.34	293.09
December	215.84	393.42	9.69	618.95	185.84	134.17	8.62	328.63
1895.								
January	203.34	1.65	.....	204.99	203.34	24.10	.....	227.44
February	203.33	8.45	17.83	229.61	203.33	22.77	18.03	244.13
March	145.00	.....	14.11	159.11	145.00	2.06	14.10	161.16
April	223.33	9.00	4.00	236.33	223.34	14.90	1.87	240.11
May	211.67	1.00	.....	212.67	211.67	12.75	.....	224.42
June	27.09	.....	.....	27.09	27.09	.....	.....	27.09
Total	2,269.58	1,394.74	83.64	3,747.96	1,989.59	693.05	104.75	2,787.39

Month.	U. S. steamer Gen. O. M. Poe.					U. S. dredge Willie.			
	Salaries and labor.	Repairs.	Subsistence.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Total.
1894.									
July	$744.79	$120.47	$325.99	$577.77	$1,769.02	$226.67	.....	$34.27	$260.94
August	759.17	35.67	221.04	345.40	1,361.28	274.33	$99.63	.....	373.96
September	759.66	14.82	255.34	272.43	1,302.25	382.50	38.33	34.62	455.45
October	788.95	.....	.....	36.00	824.95	390.00	.....	.....	390.00
November	790.00	6.00	448.85	609.28	1,854.13	381.00	16.90	99.00	496.90
December	792.83	26.25	201.57	199.10	1,219.75	296.00	.....	9.50	305.50
1895.									
January	771.83	238.00	214.76	227.96	1,452.55	74.00	.....	.....	74.00
February	529.23	15.87	15.75	158.55	719.40	104.00	.....	6.45	110.45
March	380.00	.....	15.68	199.24	594.92	107.50	.....	.....	107.50
April	932.16	.....	179.80	451.53	1,563.49	.....	56.33	.....	56.33
May	218.75	32.10	.....	20.00	270.85	.....	30.00	20.00	50.00
June	.....	33.60	.....	.....	33.60	.....	9.15	.....	9.15
Total	7,467.37	522.78	1,878.78	3,097.26	12,960.19	2,236.00	250.34	203.84	2,690.18

Detailed statement of expenses incurred, etc.—Continued.

Month.	U. S. dredge Ward.				U. S. derrick boat.			
	Salaries and labor.	Repairs.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Total.
1894.								
July	$383.50		$83.39	$466.89	$60.00		$55.48	$115.48
August	390.00			390.00	60.00		5.70	65.70
September	390.00		45.27	435.27	66.00		21.16	81.16
October	390.00			390.00	60.00			60.00
November	390.00	$5.92	73.60	469.52	60.00	$2.00	24.64	86.64
December	288.17		53.46	341.63	76.00	14.00	25.13	115.13
1895.								
January	95.00		8.00	103.00				
February	137.50		128.64	266.14				
March	137.50		8.65	146.15				
April	137.50	56.32		193.82	75.00			75.00
May	134.16	839.48	20.99	994.63				
June								
Total	2,873.33	901.72	422.00	4,197.05	451.00	16.00	132.11	599.11

SUMMARY.

Kentucky River:		U. S. dredge Ward	$4,197.05
Lock No. 1	$2,646.45	U. S. derrick boat	599.11
Lock No. 2	4,070.98	U. S. snag boat Kentucky*	220.50
Lock No. 3	4,308.31		
Lock No. 4	3,523.64	Grand total	41,757.76
Lock No. 5	3,747.96	Less amount redeposited (overpayment)	.80
Lock No. 6	2,787.39		
U. S. steamer Gen. O. M. Poe	12,966.19		41,756.96
U. S. dredge Willie	2,690.18		

*Services of watchman.

REPORT OF CAPT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1895.

MAJOR: During the past year the city and county bridge at Frankfort, Ky., has been rebuilt in accordance with plans approved by the War Department, the clear height, over a span of 174 feet, being 45.12 feet above pool level in Pool No. 4. It was required, before acceptance, that the three old bridge piers be removed to a depth of 7 feet below pool level. This work was undertaken by the contractor with a very inefficient force and plant. On October 29, 1894, in obedience to telegraphic orders from your office, the water in Pool No. 4 was drawn down until, at the lowest stage, November 3, 1894, the level was 5.6 feet below pool level. The wickets at No. 4 were closed at noon of the last-named date, and work was stopped at the same time by the laborers on the piers. The piers were only removed to the depths given below:

North pier, 3 feet below pool level.
Middle pier, 6 feet below pool level.
South pier, 5 feet below pool level.

By direction of the honorable Secretary of War it is intended, during the coming low-water season, to lower the pool again, in order to allow the bridge company to complete the removal of the piers.

A considerable portion of the work proposed under last year's project has been crowded out by lack of time, and will lapse over into the coming year.

The most important piece of work performed was the construction of a stone upper miter sill at Lock No. 3. Great difficulty was experienced in coffering the lock, and finally a dam was built around the entire upper crib-work approach and connected with the shore. The old wooden miter sill was torn out, and it was found that the fore bay of the lock was covered with two courses of timber lying on top of a masonry miter wall. This timber was torn out up to the head of the lock in order to permit coffering in the future at this point. Two courses of stone were then laid on this wall for the sill, but considerable time was lost on account of leakage of cofferdam and recutting of stones.

The dams at Nos. 2 and 3 were resheeted on the upper slope, and Nos. 2, 3, and 4 were well backed with gravel.

New lower gates for Lock No. 3 were completed at Lock No. 6, and hung very successfully by the aid of the 40-foot traveler. Coffering was necessary, however, below this lock in order to insert new pintles.

As soon as the upper dams were tightened it was noticed that Pool No. 1 began to fall quite rapidly, showing that its maintenance heretofore has been due to leakage from above. It will doubtless be necessary to do considerable work at this dam the coming year.

New upper gates are now building for Locks Nos. 2 and 4.

The upper portion of the gates at Lock No. 5 was found in very bad condition, and it was concluded to rebuild the part above water in place. They are now apparently as good as new.

A large amount of dredging was done during the year at Leestown Bar, just below Lock No. 4, and it has resulted in giving a good straight channel. Dredging for the same purpose is now being done at Clear Creek Shoal, below Lock No. 6. This will also be necessary at several other points.

During the coming year it is proposed to put in a new stone miter sill at Lock No. 4, and eventually this will be necessary at Locks Nos. 1, 2, and 5.

The severe winter has done considerable damage by scaling off the face stones at Locks 5 and 6, but otherwise the locks, both old and new, are in good condition.

The following is a detailed statement of work done:

LOCK NO. 1.

Dam.—Removed 545 feet, B. M., of old and defective sheeting and replaced it with new oak sheeting; respiked old and loose sheeting on steps of dam; built ladder 21 feet in length from lock wall to upper step of dam; placed on upper slope of dam 96 linear feet of oak sheeting.

Lock.—Painted lock gates, operating irons, and check posts; nailed two planks on miter posts of upper gates; assisted dredge *Ward* in dredging 1,845 cubic yards of deposit from upper and lower entrances and lock pit; removed ten logs from upper entrance; removed three pieces of timber from lock pit; repaired and straightened spar of operating iron that had been bent by heavy drift.

General work.—Operated and cared for the lock and other Government property; tore down and removed the old mess house; repaired tool house and outhouse; removed from lock wall and stored in tool house 200 pounds of junk, 1,000 pounds of scrap iron, 200 pounds of wire rope, and 100 pounds of dynamite which had been removed from the old U. S. snag boat *Kentucky;* cleaned ditch above slope wall; repaired ceiling of lock house with 3 square yards of plaster; removed drift from upper and lower entrances; scraped mud from behind lock gates and from arms of lock gates; broke ice in lock pit and from upper and lower entrances; painted, calked, and repaired skiff; whitewashed tool house, outhouse, and fences; repaired two spike poles; stored and stacked timber; watched and cared for barges, flats, etc.

Highest water occurred January 15, 1895, upper gauge reading 26.4 feet; lower gauge, 41.5 feet. Lowest water occurred October 27, 1894, upper gauge reading 4.1 feet; lower gauge, 6.9 feet.

LOCK NO. 2.

Dam.—Unloaded from barge 50,000 feet, B. M., oak sheeting; tore up and removed old sheeting and laid 383 linear feet of sheeting on upper slope of dam; dredged and placed behind dam as backing 590 cubic yards of sand and gravel; respiked old and loose sheeting on dam.

Lock.—Painted lock gates, operating irons, and check posts; dredged from lower entrance 210 cubic yards of sand and gravel and removed 33 logs; dredged from lock pit 35 cubic yards and from upper entrance 150 cubic yards; cleaned mud from arms of lock gates; removed drift from upper and lower entrances; scraped mud from behind lock gates; watched and cared for barges, flats, etc.

General work.—Operated and cared for the lock and other Government property; sheeted 8 linear feet of upper end of upper river crib; sheeted guide pier; whitewashed tool house and fences; destroyed vegetation on slope wall, cribbings, and walks; removed drift from lock entrances; broke ice in upper and lower approaches and in lock pit; removed snow and ice from top of lock walls and walks; scraped mud from behind lock gates and from arms of lock gates.

New upper lock gates.—Received, stacked, and dressed timbers for new upper lock gates at Lock No. 4.

Highest water occurred January 19, 1895, upper gauge reading 23.3 feet; lower gauge, 34.8 feet. Lowest water occurred October 24, 1894, upper gauge reading 0.3 feet; lower gauge, 5.3 feet. The water in Pool No. 1 was drawn off to repair Dam No. 2.

LOCK NO. 3.

Dam.—Laid 270 feet, B. M., oak sheeting on steps and placed in cribs of dam 50 cubic yards of riprap; laid 124 linear feet of oak sheeting on upper slope; placed behind dam as backing 400 cubic yards of sand and gravel.

Lock.—Painted lock gates, operating irons, check posts, and capstan; filled lewis holes in upper course of miter sill with cement; pointed part of lock walls.

New stone miter sill.—Built cofferdam across the upper entrance of lock, extending from the river lock wall around the upper river guide wall, preparatory for building new stone miter sill; removed upper lock gates; pumped cofferdam; tore out old miter sill and timbers in upper entrance; handled and assorted cut stone; placed traveler in position on top of lock wall; built small cofferdam below main cofferdam in upper entrance; laid new stone miter sill; cut recess in miter sill for cushion sticks; drilled six holes 5 feet deep for bolts to receive cushion sticks; drilled five holes 5 feet deep near outer edge of miter sill and cemented in iron bolts 5 feet long; cut quarter round on front edge of miter sill; completed miter sill and rehung gates.

New lower lock gates.—On account of convenience in building, the new lower lock gates had been constructed at Lock No. 6. Prepared skids on barge to receive gates; removed all gate timber from shed to barge; fitted and placed gates in position on barge and bolted all irons in place; painted gates; towed barge with gates from No. 6 to No. 3; built cofferdam across lower entrance; placed traveler in position across lower end of lock; removed old lock gates and beached them on opposite side of river; pumped cofferdam; removed old pintles and placed new pintles in position; filled pit and hung new gates; pumped out pit and fitted miter sill to gates by scabbing on a piece of timber 1¼ inches thick at the point and ¼ inch thick at the hollow quoin; cut recess in hollow quoins to receive heads of bolts in lock gates; completed hanging gates; removed cofferdams.

Lower shore crib.—Excavated for tie crib; tore out and removed 117 linear feet lower shore cribbing, 10 feet in depth, and rebuilt it with crib 133 linear feet long, average width 12 feet, and 12 feet high; set three check posts in position in crib; quarried, near Gratz, Ky., 130 cubic yards of riprap, towed same to No. 3, and placed it in crib as ballast; filled behind crib with earth, spawls, etc.

General work.—Operated and cared for the lock and other Government property; broke up and removed from the lower entrance six large rocks; made frame for centrifugal pump; removed from lower entrance two large pieces of timber 38 feet long; whitewashed tool house, outhouses, and fences; scraped mud from behind lock gates and from arms of lock gates; broke ice in lock pit and from upper and lower approaches; removed snow and ice from top of lock wall and walks; destroyed vegetation from slope wall, cribbings, and walks; removed drift from upper and lower entrances; watched and cared for barges, flats, etc.

Highest water occurred January 19, 1895, upper gauge reading 17.6 feet, lower gauge 27.1 feet. Lowest water occurred August 23, 1894, upper gauge reading 4.1 feet, lower gauge 6.2 feet. The water in Pool No. 2 was drawn to repair Dam No. 3.

LOCK NO. 4.

Dam.—Removed nine pieces of old and defective sheeting and replaced same with new oak sheeting; respiked old and loose sheeting on steps of dam; assisted in placing behind dam 9,067 cubic yards of sand and gravel as backing.

Lock.—Painted lock gates, operating irons, and check posts; removed old anchor irons from lock walls and cemented new irons in position; cut gauge in upper river lock wall; assisted in removing 60 logs from upper entrance; spiked sheeting on floor of upper miter sill; repaired foundation of lower river crib and sheeting on lower river crib.

General work.—Operated and cared for the lock and other Government property; built two sheds back of the lock houses, one shed, 90 by 28 feet, for constructing lock gates under, and one shed, 10 by 10 by 8 feet, for storing engines, pumps, etc.; built railroad track 370 feet long from river bank to shed; rigged derrick on upper shore cribbing for moving engines, plant, etc., from barge to river bank; moved engines, pumps, etc., from barge to shed, and stored same; repaired and painted gutter on lock house; repaired cistern; repaired, calked, and painted skiff; whitewashed tool house and fences; made frame for holding printed regulations for the several locks; removed drift from the lock entrances; scraped mud from behind lock gates and from arms of lock gates; broke ice in lock pit and from upper and lower approaches; destroyed vegetation on slope wall, cribbings, and walks; removed snow and ice from top of lock walls and from walks; received and stacked timber; watched and cared for barges, scows, derrick boat, etc.

Highest water occurred January 19, 1895, upper gauge reading 16.7 feet, lower gauge 29.6 feet. Lowest water occurred November 3, 1894, upper gauge reading 0.6 foot, lower gauge 4.6 feet. Pool No. 4 was drawn in order that the bridge piers at Frankfort, Ky., might be removed.

LOCK NO. 5.

Lock.—Constructed coffer dam across lower entrance of lock, and repaired miter sill; repaired wicket and wicket rods on all gates.

Repairs to upper and lower lock gates.—Loaded timber on barge at Frankfort, Ky., towed to Lock No. 6, unloaded the timber from barge and removed it to shed; dressed and fitted timber; dressed out miters; cut dapes for straps; made 68 blocks and 22 arms for gates; painted blocks and arms; joined and painted sheeting for gates; loaded timber on barge and towed same to Lock No. 5; dismantled gate irons; tore out old and defective timbers in both upper and lower lock gates, and from tops of gates to water's edge; rebuilt gates with new timbers; fitted and replaced gate irons; painted operating irons and lock gates.

General work.—Operated and cared for the lock and other Government property; built porch on rear of both lock houses; painted assistant lock keeper's house two coats on the outside, including the valleys and outside tin work, and the valleys and tin work and the rear porch of the lock keeper's house; removed drift from upper and lower approaches; scraped mud from behind lock gates and from arms of gates; broke ice in lock pit and entrances; destroyed vegetation on slope wall, cribbing, and walks; repaired and calked skiff; whitewashed tool house and fences; set in position frame for holding printed regulations; removed snow and ice from top of lock walls and walks; watched and cared for barges, flats, etc.

Highest water occurred January 19, 1895, upper gauge reading 18.2 feet, lower gauge 28.3 feet. Lowest water occurred November 3, 1894, upper gauge reading 5 feet, lower gauge 0.6 foot. Pool No. 4 was drawn down to permit the removal of the bridge piers at Frankfort, Ky.

LOCK NO. 6.

General work.—Operated and cared for the lock and other Government property; wheeled 5,500 brick from lock wall to top of slope fill; laid brick walk along crest of slope and around the lock houses; dug trench and laid brick drain in front of houses; filled and graded yards; sowed slope fill and yards with grass seed; repaired gutter of lock houses; transferred tools, material, etc., from tool house to barge, for shipment to Lock No. 4; whitewashed tool house and fences; scraped mud from behind lock gates and from arms of lock gates; broke ice in lock pit and in upper and lower approaches; removed snow and ice from top of lock walls and walks; destroyed vegetation on slope wall, cribbings, and walks; repaired tool house and carpenter shed; stained roof of spring house; watched and cared for barges, flats, etc.

Highest water occurred January 19, 1895, upper gauge reading 18.9 feet, lower gauge 24.8 feet. Lowest water occurred November 6, 1894, upper gauge reading 3.7 feet, lower gauge 3.3 feet.

U. S. S. GEN. O. M. POE.

The U. S. S. *Gen. O. M. Poe* has been engaged at the several locks and dams towing loaded and empty barges, dredges, scows, etc.; has removed 88 snags from the river, and ran 6,059 miles. Towed quarter boat to Steels Dam; assisted in removing cofferdam at Lock No. 4, and repairing leak in lower lock gates; assisted in building cofferdam at Lock No. 5, pumped cofferdam, and repaired miter sill, wickets and wicket rods; assisted in building cofferdams at Lock No. 3, pumped lock pit three times, laying new stone miter sill, and hanging new lower lock gates; set new pintles, and removed cofferdams; assisted in building lower shore crib; resheeted upper slope of dam; towed riprap from Gratz, Ky., to Lock No. 3, and placed same in crib for ballast; removed Government property from old U. S. snag boat *Kentucky* to Lock No. 1; removed two pieces of timber 38 feet long from lower entrance of Lock No. 3; resheeted Dam No. 2, and sheeted part of the upper river crib and guide pier; replaced foundation of lower shore crib at Lock No. 4, and repaired sheeting on river crib; assisted in dismantling upper and lower lock gates at Dam No. 5, and removed old and defective timbers from the tops of gates to water's edge, and rebuilt same; assisted in building two sheds at Lock No. 4, and in storing engines, pumps, etc., in same; built railroad track at No. 4 from river bank to shed; assisted in making survey of Big Eddy, 4 miles above Frankfort, Ky.; made measurements for upper lock gates at Locks 2 and 4; towed dredge *Willie* to the mouth of the Big Sandy River, West Virginia and Kentucky; towed lumber for repairing dredges; returned to Kentucky River, and ran from Frankfort, Ky., to Ford, Ky., with Col. Wm. P. Craighill, Maj. D. W. Lockwood, and Lieut. H. E. Waterman, inspecting log booms in the river; left Frankfort on March 20, 1895, arrived at Ford on March 21, at 7.30 a. m., and left Ford, on the return trip, March 21 at 9 a. m., arriving at Frankfort at 8 p. m. (the upper gauge at No. 6 reading 15.8 feet—about 6.1 feet above comb of dam); ran to Cincinnati, removed "doctor" and put two new injectors on boiler; made necessary changes in machinery and connections; ran to Catlettsburg, Ky., and towed dredge *Willie* to the Kentucky River; made necessary

repairs to the boat and machinery; assisted in making repairs to the Government fleet at Carrollton, Ky., calking and repairing barges, scows, flats, and dredges; assisted in handling and stacking timbers and stone, pumping barges, dredges, etc., cutting ice from around fleet while in ordinary at Carrollton, and in watching and caring for fleet and other Government property; acted as tender to the U. S. dredges *Ward* and *Willie* while dredging at the several locks; struck hidden obstruction in river and bent rudderstock, and ran to Madison, Ind., and had same repaired; put new steel wrist on shaft; inspected Government property at the various locks; repaired wheel of boat, etc.

U. S. DREDGE WILLIE.

Made alteration in dredge *Willie* by raising floor of cabin; cut, dressed, and fit carlins, joist, and studdings; dressed one side of siding; raised sides and ends of cabin 3 feet 10 inches and extended it forward 18 feet; sided up ends and sides; laid flooring on roof and covered it with canvas; rigged capstan and engine. Was towed to Lock No. 5; assisted in building cofferdam in lower entrance and repaired miter sill, wicket, and wicket rods; removed cofferdam. Was towed to Lock No. 3 and assisted in building cofferdams in upper and lower entrances, building new stone miter sill, hanging new lower lock gates; removed cofferdams and assisted in rebuilding lower shore crib; dredged from the upper entrance of Lock No. 3, 971 cubic yards of deposit. Was towed to Leestown Bar, below Lock No. 4, and dredged 3,394 cubic yards of sand and gravel, loaded same on barges and scows, towed above Lock No. 4, and placed it behind dam as backing. Was towed to Lock No. 3 and dredged 45 cubic yards of deposit from lower entrance. Was towed to Lock No. 2 and dredged from lower entrance 125 cubic yards of sand and gravel, from lock pit 35 cubic yards, and from lower approach 85 cubic yards of deposit and 33 logs; assisted in sheeting upper slope of dam; dredged 450 cubic yards of gravel below dam, loaded on barge, towed above dam, and placed behind dam as backing; dredged upper entrance of Lock No. 3. Was towed to Maceys Ripple and dredged 770 cubic yards of sand and gravel from channel of river. Was towed to Leestown Bar and dredged from channel of river 1,228 cubic yards of sand and gravel and placed same behind Dam No. 4 as backing; assisted in calking quarter boat, barges, scows, skiffs, etc. Cut ice away from Government fleet while in ordinary at Carrollton, Ky., and assisted in making necessary repairs to the U. S. S. *Gen. O. M. Poe*, barges, and Government fleet. Was towed by the U. S. S. *Gen. O. M. Poe* March 9, 1895, to the mouth of the Big Sandy River, West Virginia and Kentucky, for the purpose of doing some dredging in the Big Sandy River. Returned from the Big Sandy River May 11, arriving at Carrollton, Ky., May 14, 1895. Was towed to Frankfort, Ky.; repaired capstan and placed new backing chain on dredge; repaired deck. Was towed to Clear Creek Bar and dredged from channel of river 5,880 cubic yards of sand and gravel and 23 stones; watched, pumped, and cared for barges, scows, flats, and other Government property.

U. S. DREDGE WARD.

Assisted in removing cofferdam from lower entrance at Lock No. 4, which had been used in hanging new lower lock gates; dredged from upper entrance at Lock No. 4 150 cubic yards of deposit and 20 logs, and from lower entrance 125 cubic yards, and from lock pit 50 cubic yards. Was towed to Lock No. 1 and dredged from lower entrance 1,385 cubic yards and 10 logs, and from upper entrance 280 yards, and from lock pit 180 cubic yards of deposit. Was towed to Lock No. 5 and assisted in constructing cofferdam, excavating backing for coffer dam, and repairing lower miter sill; removed cofferdam. Was towed to Lock No. 3 and assisted in building cofferdams at upper and lower entrances for use in building new stone miter sill and hanging new lower gates; removed cofferdams; dredged 1,796 cubic yards of sand and gravel for backing cofferdams; dredged from lower entrance 50 cubic yards of deposit, 70 cubic yards from lock pit, and 300 cubic yards from upper entrance; dredged 240 cubic yards of sand and gravel below dam for backing Dam No. 3. Was towed to Leestown Bar and dredged 4,445 cubic yards of sand and gravel, loaded same on barges and scows, was towed to above Lock No. 4, and placed the dredged material behind dam as backing; raised and pumped sunken barge at Lock No. 4; assisted in making necessary repairs to U. S. S. *Gen. O. M. Poe*, dredge *Willie*, and the Government fleet; assisted in calking barges at Carrollton, Ky., repairing machinery, etc. Made the following repairs to dredge: Dressed, framed, and fitted timbers for repairs to dredge; made 2 spud posts and 1 crosspiece; fitted irons on spuds and cross timber; fitted irons on forward frame of dredge; unshipped crane and turntable and removed old irons; removed old and defective timbers in front of dredge; placed new spuds and cross timbers in position; moved and reset capstan engine in position and made steam connections; hung swinging crane in position; bolted irons in position on crane; drilled holes in four iron brackets and placed brackets in position on forward frame of dredge; placed new swinging engine in position and made steam connections. Repaired and overhauled machinery. Was towed to Clear Creek Bar, 1 mile below Lock No. 6, and dredged from the bar 5,026 cubic yards of sand and gravel.

U. S. DERRICK BOAT.

Assisted in removing cofferdam at Lock No. 4. Was towed to Lock No. 5 and assisted in building cofferdam and repaired miter sill, wickets, and wicket rods. Was towed to Lock No. 3, assisted in building cofferdams, laying new stone miter sill, hanging lower lock gates, and rebuilding lower shore guide crib; assisted in handling timber and stone and in removing cofferdams. Was towed to Lock No. 4 and assisted in unloading barges and scows of sand and gravel behind Dam No. 4 which had been dredged at Leestown Bar; removed 60 logs from upper entrance of Lock No. 4; loaded timber on barges at Frankfort. Was towed to Lock No. 4 and unloaded same; assorted and stacked lumber and stone at the several locks as required; watched, pumped, and cared for barges, scows, flats, etc.

U. S. SNAG BOAT KENTUCKY.

In ordinary at Carrollton, Ky., until October 27, 1894, on which date the boat was sold at auction.

Respectfully submitted.

H. E. WATERMAN,
Captain of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers.

List of stern-wheel boats plying on the Kentucky River, Kentucky.

Name of boat.	Character.	Length.		Breadth.		Depth.		Tonnage.
		Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	
Kentucky	U. S. snag boat	136	6	30	0	4	6	330
Gen'l O. M. Poe	U. S. towboat	127	0	30	0	5	0	300
Falls City	Packet	132	5	27	0	4	4	223.35
John Barrett	do	124	8	31	0	5	5	187.23
Rescue	do	121	0	28	0	4	0	139.03
Enos Taylor	do	116	0	20	0	3	6	64.78
Henrietta	do	101	5	16	3	3	6	48.59
Little Sandy	do	94	0	16	0	3	0	39.34
J. F. O'Connell	do	92	6	18	1	3	4	54.74
W. L. Norton	do	76	0	12	0	1	6	43.60
Ghent*	do	53	0	10	0	4	0	4.85
Tom Ross	do	33	0	6	6	3	6	9.72
Angler	do	36	0	9	0	4	0	7.10
Jim Montgomery	do	80	0	18	0	2	6	28.85
Al. Martin	Towboat	112	0	23	6	4	0	96.68
Alex Montgomery	do	112	0	24	0	4	0	85.55
Troubadour	do	97	0	18	0	3	0	61.37
Andy*	do	85	0	11	0	7	0	45.40
D. D. Baker	Saw boat	117	0	18	3	4	3	70.83
Sawyer	do	116	0	18	0	4	2	70
Rover	do	100	0	18	0	3	6	65
Dixie*	Pleasure boat	45	0	8	6	4	0	3.72
Flirt*	do	28	0	5	6	3	6	1
Lotos Eater*	do	25	0	6	0	2	6	1.50
Oneota*	do	25	0	5	8	3	0	1
Inez*	do	21	0	6	0	3	6	1.50

*Screw propeller.

Report of lockages on Kentucky River, Kentucky, for the fiscal year ending June 30, 1895.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1	344	21	415	141	22	424	142	83	32	1,259	1,155
No. 2	329	36	399	121	68	398	119	87	82	1,274	1,185
No. 3	330	35	264	167	59	266	173	94	67	1,090	976
No. 4	340	25	314	263	158	315	270	96	177	1,593	1,389
No. 5	316	49	155	63	79	150	59	1,033	83	1,622	1,175
No. 6	344	21	101	25	130	101	28	1,065	148	1,598	900
Total	.....	.....	1,648	780	516	1,654	791	2,458	589	8,436	6,780

G G 8.

IMPROVEMENT OF LICKING RIVER, KENTUCKY, BETWEEN FARMERS AND WEST LIBERTY.

The project for the improvement of this river was approved by the Secretary of War under date of September 20, 1888, and provides for the removal of snags, detached rocks, and bowlders, with a view to improving low-water navigation and rafting.

During past years the stretch of river between Farmers and West Liberty, 68 miles in extent, has been improved each year that appropriations have been made, so far as the amount of money available would permit, the object being to enable light-draft boats to use the river at a lower stage than was formerly possible and to facilitate rafting. No work was done during the past fiscal year, there being no money available.

The original estimate of the cost of this improvement was $17,680, and it is recommended that of the balance yet unappropriated, $5,000, be appropriated for the fiscal year ending June 30, 1896.

The river, under the present project, is not susceptible of permanent improvement for the reason that such obstructions as snags, leaning trees, stumps, etc., are liable to occur after each high water.

APPROPRIATIONS.

August 11, 1888	$3,000
September 19, 1890	3,000
Total	6,000

Money statement.

Amount (estimated) required for completion of existing project	$11,680.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

NOTE—It has been impossible to obtain commercial statistics.

G G 9.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks, flows north a distance of 26 miles, and empties into the Ohio at Catlettsburg, Ky. The main river and the Tug form the boundary between Kentucky and West Virginia, and the upper Tug, for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia and flows northwest to its junction with the Levisa Fork, with a total length of 140 miles. The Levisa Fork rises in the southwestern part of Virginia, then entering Kentucky flows in a northerly direction. Its total length is about 189 miles.

The original project for improvement was adopted in 1878, and provided for the removal of obstructions from the Big Sandy and its two forks, in order to facilitate push-boat navigation and rafting.

In 1880 this project was modified with a view to securing slack-water navigation by a system of locks and dams, and the first lock and dam

were located at Louisa, Ky., just below the junction of the two forks, for the reason that the pools formed in the forks could be used for storage purposes during low water, and thus afford advantages for mining coal that no other location for a single lock could give.

The original project provided for a fixed dam, and, at the end of the season of 1890, the lock, with its fittings, and the abutments, as well as about 80 feet of the dam, had been constructed.

The timber and shipping interests of the river having made objections to a fixed dam, under date of May 20, 1891, a Board of Engineer Officers was constituted "to consider and report upon the subject of the dam to be built in the Big Sandy River."

In its final report this Board recommended the substitution of a needle dam for the fixed dam, the clear height of the pool formed by it to be 13 feet above the sill of the navigable pass.

Under date of March 1, 1893, I had the honor to submit a partial report on movable dam proposed for this river, with maps showing the general features of the work. These were approved under date of March 6, 1893.

The approved plan calls for a navigable pass 130 feet long and a weir 140 feet long, separated from the pass by a pier.

Under date of May 3, 1894, maps, giving details of the movable parts, were forwarded to the Chief of Engineers, and approved May 10, 1894.

The elevation of the sill of the pass is placed at the extreme low-water mark at the time the lock was built, thus placing it 9 inches below the lower miter sill of the lock.

It has been surmised, for a number of years, that the bed of the Big Sandy was slowly coming up, due to the increased washing of the banks from their being cleared up, and the large quantities of sand brought into the main stream from the tributaries by the use of splash dams in getting out logs. Whether this is a permanent condition or not can hardly be determined at present, but certain it is that, at times, there are large deposits of sand in the river near the lock, which disappear as the conditions change, and which may or may not cause trouble in the future.

I am of the opinion that there has been no great change in the bed of the river beyond what always happens when an attempt is made to improve low-water navigation in streams of this sort by lowering the ripples separating the pools. The tendency in such cases is toward a more uniform slope by the filling up of the pools.

The masonry of the pass, weir, pier, and abutment is now completed, ready for the movable parts of the dam, and the banks above and below lock and abutment graded and paved; lock-houses will be constructed this season, with the exception of plastering and finishing inside.

For details of work done during the past year, attention is invited to report of Assistant Engineer B. F. Thomas, herewith.

APPROPRIATIONS.

July 18, 1878	$12,000	August 11, 1888	$31,500
March 3, 1879	12,000	September 19, 1890	31,000
June 14, 1880	50,000	July 13, 1892	50,000
March 3, 1881	46,000	August 17, 1894	40,000
August 2, 1882	15,000		
July 5, 1884	40,000	Total	350,000
August 5, 1886	22,500		

Money statement.

July 1, 1894, balance unexpended	$1,150.40
Amount appropriated by act of August 17, 1894	40,000.00
	41,150.40
June 30, 1895, amount expended during fiscal year	20,358.87
July 1, 1895, balance unexpended	20,791.53
July 1, 1895, outstanding liabilities	2,536.86
July 1, 1895, balance available	18,254.67
Amount (estimated) required for completion of existing project	30,151.58
Amount that can be profitably expended in fiscal year ending June 30, 1897	30,151.58
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1895.

MAJOR: The report upon Big Sandy River, West Virginia and Kentucky, for the fiscal year is herewith respectfully submitted.

The work accomplished during the year may be briefly summed up as follows:

1. Completion of weir, pier, and abutment masonry, which also includes the construction of a cofferdam, the cutting of stone, the tearing out and removal of old abutment, and the excavation inside the cofferdam, as well as the putting in of a concrete foundation.

2. The removal of the old waste dump which obstructed the river outside the lock and below and above the pass.

3. Placing all fixed iron work on the weir.

4. Grading and paving and riprapping the West Virginia bank and grading the Kentucky bank.

Owing to the late date at which the money became available work was not begun until the 29th of August, but it was carried on full time, day and night, when started, and the season being very favorable, and the water quite low, a great amount of work was accomplished in a short period of time and at much less expense than it has been possible to do it at this place heretofore.

Cofferdam.—Experience with a narrow pile coffer for the pass caused me to build a much wider one, partly of piles and partly of cribs, for the weir, and although the foundation was deeper than that of the pass, there was much less trouble with it. As no dredge was available to excavate the site, so that a pile-driver boat could float all over it, it was necessary to construct trestles over the part covered with water, and drive the piles with a land driver, moved along these bridges. Next the bank the earth was dug away to the level of these trestles, which was slightly above low water, back into the hill some 30 feet behind the rear of the abutment. Two rows of piles placed some 6 feet apart, across the stream, and 12 feet with the stream, were driven above and below the weir, and cut off at low-water mark. On top of these was placed sawed timber crib-work lined with plank. Sheathing or sheet-piles were driven along the lines of piling and cut off at crib line. Where possible, clay or gravel was filled in the spaces below the water line, but the cribs above the water were left empty, so as to have as little weight as possible against the sheet-piles and piles, the intention being to fill them when a rise should threaten the coffer. Happily this did not occur. At the bank end of the coffer two rows of close piles, placed in the form of an arch, were driven, and the front row was tied to the rear row with timber. Connection was made at the outer end with that part of the pass coffer which had been left in for this purpose. Four thousand six hundred and forty-five linear feet of piling and 6,610 feet of 2-inch and 10,610 feet of 1-inch sheet-piles were driven; 1,550 linear feet of 9 by 12 inch and 5,620 linear feet of 10 by 10 inch timber, and 19,714 feet, board measure, of lumber, were used in the construction and maintenance. All of this timber was purchased, originally, for the stationary dam, the sheet-piles being sawed on the work. The material excavated from the banks, and from inside the coffer, was used for banking up outside, and as this bank increased in width the coffer became comparatively dry and easily kept in good condition for work inside. The bank springs, which have been the greatest cause for apprehension of trouble, and to crowd out which the two rows of close piles 12 inches square had been driven, proved of real benefit by washing the sand to the pump whence it could be carried out with the water. A truss, connecting the two sides of the coffer, was built at the point where it would least interfere with the swing of the building

derricks, on which the pump was placed. As the excavation got deeper the pump was lowered onto beams braced to the bridge and supported by iron rods. At the river or pass end of the cofferdam a box with valves or gates was built through the walls for the purpose of letting in water from the river at such times as the leakage did not furnish sufficient to wash the sand to the pump. In this manner a great deal of the lighter material was removed by the pump without labor, except such as was required to loosen it and cast it into the water. Troughs were sometimes used for directing the water and sand to the pump, but generally ditches cut in the material answered the purpose. The great bulk of the material, however, was removed with steam derricks and dump boxes; 5,756 cubic yards were thus taken out, and 2,090 cubic yards were removed from above water at the bank end; 5,760 cubic yards were excavated by men from the dump outside of lock, in order to form a passage for the river after the weir coffer was built; 726 cubic yards of clay were put into the coffer walls, and the banking around the outside of coffer amounted to 4,259 yards, not counting that which went out through the pump. When the excavation had reached a point some 6 feet above bed rock, gravel was found, and this continued to the rock and was of great service in holding the bottom of the sheeting piles and piles in place. The bed rock was reached at from 18 to 22 feet below water level, but was not of good character, being quite shelly, and sometimes soft and mixed with coal seams.

Construction.—The greater part of the stone had been cut previously, as it was originally built into the abutment for the stationary dam, but it was necessary to cut 88.75 cubic yards of special stone and 122.90 cubic yards of pitch-face stone. These were cut from those taken from old abutment, and from a pile of unused stone in the yard. Eight hundred cubic yards were taken out of the old abutment, and the cement cleaned off, and the stone used.

The foundation was made of concrete, 24 feet in width with the stream, and averaging over 4 feet in depth. A mixer was made on the works. The breaking of stone was done by men with small hammers. Eight hundred and ten cubic yards of concrete were put in.

The work under way consisted of the completion of the pier, and the construction of the weir and abutment, and the completion of the masonry adjoining the lock wall. Two steam derricks, with double-drum engine midway between, were placed 100 feet apart on the lower wall of the coffer, and one opposite this engine on the upper wall. Thus the three derricks reached each other, and the whole length of the masonry, 170 feet. Stones were brought in on tracks reaching to the old abutment (which was torn down as needed) and, by an inclined track, to the pile in yard. Norton's "Rosendale" cement was used, and the sand was taken from inside the coffer and from the adjacent banks. One thousand seven hundred and seventy-six cubic yards were laid in the weir, 127.31 in the pier, 352 in the abutment, and 16 in the lock wall, making a total of 2,271.31 cubic yards; stone to the amount of 3,684 cubic yards was handled in order to get this amount, it being necessary to overhaul the piles in order to get suitable stones. The weir masonry is built in two walls standing some 7 or 8 feet apart on the concrete. Between these walls the space is filled with hammered stone up to within 7 feet of the top, or coping when concrete is used; broken stone to the amount of 325 cubic yards was so used.

The space behind the abutment, and between it and the cofferdam, was filled with broken stone, 1,500 cubic yards being put in, and 775 yards of broken stone were put in below the masonry and between it and the lower wall of the cofferdam. This stone, as well as 1,159 cubic yards taken out for concrete and coffer protection, all came from the waste dump lying outside the lock and below, making a total of 3,434 cubic yards removed from that dump. The sill of the weir is cast iron, made in sections about 8 feet long. These were all placed and anchored with large disks and bolts to the masonry. The journal boxes, tie-rods, and other fixed iron work was put in place. The driftbolts, holding in place the upstream and downstream tiers of coping, were also put in place. About 38,000 pounds of iron was put in.

General work.—Work was suspended in December, the masonry having all been completed, and was not started again until March, when dredging out the waste dump lying above and below the pass was commenced and carried to completion early in May; 11,445 cubic yards were thus taken out, the rock being saved for riprapping the banks and the gravel and sand being deposited at convenient points out of the way of navigation. The pass chute is now in very good condition, although there is still some cleaning to do as soon as the river is sufficiently low. The bank on the Kentucky side has been graded ready for paving and riprap, and a road has been made from the county road down to the river. On the West Virginia side the bank has all been graded and riprapped above the lock, and 150 feet below the lock, and the space behind the lock has been graded and partially paved; 2,922 square yards of riprap and 650 square yards of paving have thus been put in, and 5,111 cubic yards of earth, rock, etc., have been removed.

Work upon the stone cutting for the foundations of the lock-tenders' dwellings has been commenced, and 382 linear feet of stone have been made ready; contracts

for furnishing the timber and material for the construction of the lock-tenders' dwellings have been made; the dwellings will be erected during August and September, but will not be plastered or finished inside until next season.

A great deal of drift accumulates on the head of the river wall of the lock during freshets, which greatly interferes with navigation, and it has been decided to put in a crib, or "glancer," shaped so as to turn the drift out into the current; a contract for the timber for this has been made, and it will be built during August. The stone for filling it are on hand.

The work remaining to be done is the paving and riprapping of the Kentucky bank, and part of the West Virginia bank; construction of lock-tenders' dwellings; building the crib at the head of the lock; construction of gates for the lock and trestles and needles for the dam, and some general work of a varied character.

Summary of work.—The statement given below shows quantities of materials used, and work performed:

Stone cut, special and pitch-faced	cubic yards	227.65
Masonry laid weir, pier, abutment, and lock wall	do	2,271.31
Concrete put in weir and abutment	do	810
Excavation by dredge from pass chute	do	11,445
Excavation by men, in coffer, chutes, banks, etc	do	19,094
Sheet piles driven in cofferdam	linear feet	17,220
Piles driven in cofferdam	do	4,645
Lumber used in coffer and elsewhere	feet, B. M.	77,697
Cement used in masonry and concrete	barrels	2,000
Iron used	pounds	38,046
Stone removed from old abutment	cubic yards	800
Coal used by dredge and yard boilers	tons	284
Oil used for lighting the works	gallons	1,165
Oil used for lubricating	do	102
Nails and spikes used	pounds	4,197
Bolts used	do	6,794
Oakum used	do	437
Waste used	do	132
Gum packing used	do	50
Tallow used	do	225
White lead used	do	50
Torch wicking used	do	24
Steel used	do	140
Chain used for dump boxes	do	81
Handles used for picks, axes, and hammers	dozen	21

It is the intention, during the present season, to complete the bank protection, build the dwellings ready for plaster and inside finish, build the crib at head of lock wall, clean the channel above and below the pass and before lock, and do a little work in the lock.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. D. W. LOCKWOOD,
Corps of Engineers.

Commercial statistics for fiscal year ending June 30, 1895, Big Sandy River, West Virginia and Kentucky.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Hides	75	50	40	95	.....	.....
Leather	34	30	4	6	.....	.....
Lumber	3,000	3,000	60	650	400	500
Produce	2,511	3,000	250	1,755	2,000	3,000
Live stock	495	500	150	1,100	800	1,300
Spokes	750	2,200	4,080	530	100	50
Staves	7,000	1,050	5,260	1,803	1,500	1,000
Tan bark	9,831	10,000	28,950	1,950	1,000	800
Timber, logs, and knots	208,491	225,000	300,050	331,570	200,000	425,000
Ties, railroad	15,000	10,000	99,625	68,750	40,000	32,100
Wheat	510	489	.....	.....	.....	.....
Wool	11	15	7	7	.....	.....
Miscellaneous	19,000	21,069	16,050	55,914	50,500	80,000
Passengers	1,874	900	1,400	2,503	1,500	2,100
Total	268,582	277,303	455,026	466,723	297,800	545,910

List of boats plying on Big Sandy River, West Virginia and Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Beulah Brown	Side-wheel	118	15	2.5	37.71
Sip Bayes	do	100	14	1.8	24.12
Andy Hatcher	Stern-wheel	117	18	3	65
J. C. Hopkins No. 2 *	Side-wheel	120	18	2.8	
Jennie George	do	93	14	2.5	19.05
Fairplay	do	125	19	3	49
Frank Preston	Stern wheel	110	18	3	60
Sandy Valley	Side-wheel	105	14	2.8	40
Virgie Ratcliff	do	110	15	2.6	43
Stella (tow)	Stern-wheel	90	16	2	25
Buckeye Boy (tow)	do	137	20	3.5	
Gate City (tow)	do				
Sea Lion (tow)	do	123	22	3.5	127
J. C. Hopkins (saw boat)	Side-wheel	102.5	16.4	2.4	67
Champion (tow)	Stern-wheel	113	21	3.2	60.15
J. H. McConnell (tow)	do	120	22	4	137

*New line.

G G 10.

IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

The Levisa is the western of the two forks that unite at Louisa to form the Big Sandy River. It rises in the southwestern part of Virginia, at an elevation of about 1,500 feet above tide water, and flows in a northerly direction. Its banks in many cases are rocky, in others composed of sand and clay. It possesses all the characteristics of a mountain stream, a steep average slope, and pools of varying depth, separated by rock, bar, or ripples, that at low water often have but a few inches of water over them. The average fall from Pikeville to Louisa is 1.49 feet per mile, the distance being 86½ miles.

The object of the improvement has been to facilitate rafting and push-boat navigation in the upper river and to improve low-water steamboat navigation so far as this can be done. Steamboats can not run in this or Tug Fork at dead low water, but the work done so far has been of such character as to permit of their running on smaller rises than was the case before the improvement was commenced. Push-boat navigation during low water is a very important matter on this stream, owing to the fact that there are no good roads for hauling freight, and a few inches increase in depth is a matter of no small moment to freighters. Coal mines have been opened at and near Peach Orchard, and quite extensive shipments are made by rail to Ashland, on the Ohio, where it is put in barges for transportation down the river. Could coal be shipped by water from the mines the output of coal would be largely increased.

The work of previous years has removed the most important obstructions, so that during the past season it was only necessary to clear out chutes that had become obstructed by material washed in during the preceding high water and take out such obstructions as logs, stumps, and snags that are always found in the channel after a rise.

The stream under the present project is incapable of permanent improvement, as the obstructions to navigation, such as snags, stumps, logs, etc., are liable to re-form at any time, and an annual appropriation of about $2,500 is needed to keep it clear.

For details of work done during the past year attention is respectfully invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

APPROPRIATIONS.

June 14, 1880	$2,500	September 19, 1890	$2,500
March 3, 1881	2,000	July 13, 1892	2,500
August 2, 1882	5,000	August 17, 1894	2,500
July 5, 1885	5,000		
August 5, 1886	3,750	Total	25,750

Money statement.

July 1, 1894, balance unexpended	$64.08
Amount appropriated by act of August 17, 1894	2,500.00
	2,564.08
June 30, 1895, amount expended during fiscal year	1,421.88
July 1, 1895, balance unexpended	1,142.20
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,500.00

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1895.*

MAJOR: The work upon Levisa Fork of Big Sandy River for the fiscal year has been similar in character to that heretofore done upon that stream, i. e., the removal of snags, trees, stumps, etc., forming obstructions to navigation, the clearing of loose rock from the shoals, blasting large rocks from the bends, and repairing walls and existing works of contraction and protection.

A party of 14 men in charge of Mr. J. C. Butler was started out September 12, going to a point 2 miles above Pikeville, and returning November 30, 1894. In detail, the work done was about as mentioned below.

A large rock was blasted in the bend at Doc. Miller's, and some very bad snags were taken out in the same locality and above. At Georges Creek, which is always a dangerous place to river men, and which has to be cleaned up every year, the usual number of obstructions were taken out. Quite a number of trees were topped in this section of the river. Graves Shoal, 20 miles above the mouth of the river, which was one of the worst places for navigation before the Government began work upon the stream, is now in good condition and requires but little work, the shoal having practically disappeared. The same may be said of Bumblebee Shoal, Jim Jeff Ripple, and Lock Creek Shoal—all have washed out and disappeared. There are several rocks near Graves that should be removed for the safety of running timber; otherwise that part of the river is in fair condition. Some badly needed improvements were made at Chestnut Shoal and near there, the removal of three logs, the blasting of some large rocks, and the building of a wall 275 feet long, with 10 feet base and 2 feet height, on the east or bend side, being the principal work done. At Joe Davis 11 rocks were blasted out for the benefit of raftsmen. At Whitehouse Shoal, where so much trouble has been encountered by river men heretofore, but little work is now required, the repairing of the walls being about all that is necessary. The big rock at the head of the upper ripple, which has been an obstruction in extreme low water, was taken out. At Redhouse 63 yards of solid rock was removed, and there is considerable work yet to be done there with dynamite, as the bend is very sharp and the rocks make it dangerous at high stages of water. Two hundred and twenty-seven feet of new wall was built at Wild Goose Shoal, one wall 100 feet long and 4 feet high at head of shoal and two cross walls at foot of shoal, to counteract a cross current that sets in at this point. On account of the scarcity of rock at this place it will be necessary to boat some and do more work later on. A little wall was built at the Jim Ward Ripple, and the old walls at Greasy were repaired and 200 feet of new wall built. Near the head of Greasy Shoal a little cross wall 3 feet high was put in on the west side as an experiment to see what effect it will have on the current, which is very swift at this point. Two hundred feet of wall was built at Buffalo Shoal, and some large rocks were shot out, and the old walls were repaired; in all, 1,100 feet of wall was built in this locality.

It is a strange thing that the betterment of one shoal frequently develops trouble in some of its neighbors. Conley Shoal, which never caused trouble before, has now become very swift and shallow, and the current has attacked the bank, and it has been found necessary to riprap it. A wall 100 feet long was also put in on the west

side, running across the river to divert the current. Above this shoal a rock containing 76 yards was blasted out, and many trees and snags were removed, and the shoals were all cleaned out and made safe, and a tree 80 feet long and 10 feet girth was taken out at Prestonsburg. At the shoal at that point a wall 240 feet long was put in at the head, and one 140 feet long was put in at the foot, to try to confine the water to one channel.

For 20 miles above Prestonsburg there was but little to do aside from cleaning out shoals and removing trees and snags.

At Grimes Shoal, 74 miles above Louisa, 300 feet of new wall was built, and 200 feet in John Lee Hatcher Shoal; and at Long Shoal, 10 miles above Grimes, over 2,000 feet of wall was built, the old walls having all been torn down and washed away, no work of consequence having been done there for some years. These new walls contain 756 cubic yards of stone, and boats can now go through on 6 inches less water than formerly. At Pikeville some snags, etc., were taken out at public landing, and just above a snag which sank a boat some time since was removed. Other obstructions at various points on the river were removed, and the channel was left in excellent condition. It has been several years since any work was done above Pikeville, and it is proposed to expend the most of the balance on hand on that stretch of river this summer, as a wharf boat has been established at Powells Dam, 13 miles above Pikeville, and steamboats are now frequently called to go up there in good water, and it is not safe to do so in the present condition of the river. It will not be necessary to clean the shoals, as neither boats or rafts will attempt to run in low water, but it is proposed to remove all snags, trees, and sharp protruding points of rock which might endanger navigation at good stages.

It is believed that the biennial appropriation of $2,500, if continued, will maintain the river in good navigable condition.

The following is a summary of work done the past season: Snags removed, 254; trees removed, 71; stumps removed, 80; trees topped, 12; solid rock removed, 919 cubic yards; loose rock removed, 5,580 cubic yards.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

NOTE.—Commercial statistics included in the report for improving Big Sandy River, West Virginia and Kentucky.

G G 11.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Tug Fork is the eastern of the two forks which unite at the town of Louisa, 26 miles from the Ohio, to form the Big Sandy River. It rises in the southwest corner of West Virginia and flows toward the northwest for a distance of 140 miles. For a distance of 18 miles at its head it forms a part of the boundary between Virginia and West Virginia, and below this it and the Big Sandy form the boundary between West Virginia and Kentucky.

The Tug throughout most of its length is a characteristic mountain stream formed of a series of pools separated by ripples.

The average fall per mile from Pond to Warfield, a distance of 23.5 miles, is 1.96 feet per mile, and from Warfield to Louisa, a distance of 35 miles, 1.72 feet per mile.

The object of the improvement has been to facilitate rafting of logs from the upper portion of the stream and its branches, to provide a low-water push-boat channel, and to make it possible for light-draft steamboats to run at lower stages than formerly while the river was in an unimproved state.

The work done has been that of clearing the channel of rocks, snags, stumps, etc., and the banks of overhanging trees, while with special reference to push-boat interests, channels have been cut through the ripples or shoals.

The Government has improved this river from its mouth at Louisa to Bailey's Dam, a distance of 100 miles.

The effect of the work done from year to year has been to extend the time during which steamboats could run, and the result has been very beneficial, owing to the fact that the roads in the section of country adjoining the stream are very poor, and freighting is carried on almost entirely by water.

The improvement of the stream under the present project is incapable of completion, as obstructions, such as snags, logs, stumps, etc., are liable to occur with every high water, and an annual appropriation of $2,500 is needed to remove them.

For details of work done during the past fiscal year, attention is invited to report of Assistant Engineer B. F. Thomas herewith:

APPROPRIATIONS.

June 14, 1880	$2,500	September 19, 1890	$2,500
March 3, 1881	2,000	July 13, 1892	2,500
August 2, 1882	5,000	August 17, 1894	2,500
July 5, 1884	5,000		
August 5, 1886	3,750	Total	25,750

Money statement.

July 1, 1894, balance unexpended	$36.64
Amount appropriated by act of August 17, 1894	2,500.00
	2,536.64
June 30, 1895, amount expended during fiscal year	1,495.14
July 1, 1895, balance unexpended	1,041.50
July 1, 1895, outstanding liabilities	81.08
July 1, 1895, balance available	960.42
Amount that can be profitably expended in fiscal year ending June 30, 1897. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,500.00

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1895.*

MAJOR: The report upon the improvement of the Tug Fork of the Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1895, is respectfully submitted.

The work was begun September 12, 1894, and was placed in immediate charge of Fred. McHenry, with a crew of 14 men.

The river was very low, and much time was consumed in moving the boats, but as the money was not available sooner it was out of the question to take advantage of the good water earlier in the season.

The lower 20-mile section of this fork has a sand bottom, and the water spreads over it in such manner that it is almost impossible to maintain a permanent channel. Ten or fifteen years ago there were several shoals in this part of the river and quite a little fall at what was known as the "Falls of Tug;" now, however, these shoals, as well as the falls, have all been buried out of sight by sand, and instead of a series of pools and rapids, as is customary on rivers of this character, there is now a regular grade from the mouth for a distance of over 20 miles. This may be attributed to two causes: First, the longer tributaries have been dammed for the purpose of getting out logs, and the water is held back as long as possible and then

it is all released at once to make a tide on which to float out the timber; the increased velocity and discharge cuts away the soft banks of the creeks and carries the material out into the main stream and deposits it wherever a hole is found. The other cause is the clearing up of the land adjacent to the river, allowing the banks to wash and the river to widen, the material being carried into the stream. Another cause is assigned, and by many believed to be the principal one, and that is that lowering the shoals year after year in order to maintain the channel through them, the water has been drained out of the pools and a more regular grade established—that is, instead of having all the fall at the shoals it is extended to the pools as well.

The principal work done during the past year is as below:

A large rock was blasted out at Mulberry Bottom, on the east side of the river, and also one at L. Vinson's on the opposite side.

Some snags in this region, which had become troublesome to rafts, were also taken out. The river makes a very short bend at Lost Creek, 10 miles from the mouth, and just below the bend there is a large ledge of rock, which for years has been quite a difficult thing to get over with rafts, as it stands out in the middle of the river; but there were so many places requiring attention that it was not reduced until last season. It is 200 feet long and 8 feet thick, and 325 cubic yards was taken off it. Just below this ledge a small island was removed and a wall, confining the channel, was built; it is 150 feet long, with base of 8 feet.

Just above the falls three large and four small rocks were blasted out, and some snags above that point were removed.

Copley Shoal was cleaned out and some rocks at that point were blasted, and also some at Twisting Shoal, which was also cleaned out. The stone removed was placed on the walls that had been built some years ago, and this is the case throughout the river, i. e., the stone removed when cleaning the shoals or blasted from the river is used to strengthen the walls.

The John Smith Shoal was cleaned and some large rocks near there were blasted, and a wall 200 feet long and 10 feet base was built. The gravel bar, just below the bend at this point, which was about 5 feet high was taken out to a depth of 3 feet, about 325 cubic yards of gravel, bowlders, etc., being removed.

All snags interfering with navigation between Copley and John Smith Shoal were taken out. Endicott Shoal, Whitt Bar, Calf Creek Shoal, Turkey Shoal, Jennies Creek Shoal, Crums Dam, Silver Creek, Lick Shoal, Bull Shoal, Marrowbone, and Buck Creek Shoal were all cleaned out and the walls repaired. All snags forming obstructions between these points were removed, and some large rocks were blasted out, nine being removed at Calf Creek alone. In the Jennies Creek bend the rocks were removed from a bar which has formed there, and the gravel was loosened up so as to give the current a chance to remove the bar. A wall 200 feet long, with 9 feet base, was built here, and 12 large rocks were blasted. This place can be further improved by blasting some large rocks below the shoal. Marrowbone Shoal had previously been improved successfully, but an island had formed at the head which caused considerable uneasiness to timber men, the shoal being in a sharp bend where there is but little chance to dodge with rafts. This island was removed, and the stone taken from it was used to build a wall 200 feet long and 8 feet base as a protection to the bank. Some more work is required here, a rock containing about 700 yards just below forming an obstruction which should come out soon.

At Buck Creek Shoal no work of consequence had been done for some years, and it was found necessary to give it a thorough overhauling. A rock containing 40 yards stood 2½ feet above low water, and it was taken out and walls were repaired and 800 feet of new wall was put in. The chute was straightened considerably. This place is at Warfield, 34½ miles above the mouth of the river. Wolf Shoal comes in 2 miles farther up, and has required more work than any place on the river. It is very long and swift, and it is hard to make the walls stand or keep the chute open; the shoal may be thoroughly cleaned and the walls repaired one season, and the next season will find that the ice and freshets have piled rocks and gravel in the channel and carried parts of the walls right into the chutes. Last season was no exception, 75 cubic yards of solid rock and 835 cubic yards of loose rock and gravel were removed at this point, and 650 feet of new wall was built, and all the old walls were repaired, requiring seven days' work. Above this point work was done at Sand Gut Shoal, Jim Starr Shallows, Yoces Sluice, John Pasleys Shoal, Long Branch Shoal, Carter Ripple, Pigeon Shoal, Mount Sterling Shoal, Coleman Shoal, Millers Creek, Big Creek, Jim Taylors Shoal, Alley Island, and Buffalo Shoal, and all snags forming obstructions to navigation were taken out between these points. A great number of solid rocks were blasted out, the walls were repaired, and the chutes were cleaned. A wall 125 feet long with 7 feet base was built at Sand Gut; one 600 feet long was built at Long Branch, and the old ones were repaired; 200 feet of wall was put in at Coleman Shoal, and a wall was built at Alley Island to protect the bank on the east side.

The season being well advanced and the water too low to move boats advantageously the crew turned back from Buffalo Shoal, 57 miles above the mouth of the river at Louisa, where they arrived and were discharged December 8, 1894.

The balance on hand will be expended during the present season in further improvement and maintenance. I think the river can be kept in good condition with the appropriation of $2,500 every two years, as heretofore made, if continued.

The season's work sums up as follows: Snags removed, 205; trees removed, 42; stumps removed, 135; solid rock removed, 1,218 cubic yards; loose rock removed, 5,025 cubic yards.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. D. W. LOCKWOOD,
Corps of Engineers.

NOTE.—Commercial statistics included in the report for improving Big Sandy River, West Virginia and Kentucky.

G G 12.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The Guyandotte River rises in the southwestern part of West Virginia, and flowing in a northwesterly direction empties into the Ohio 12 miles above the mouth of the Big Sandy and 39 miles below the mouth of the Great Kanawha.

The project for the improvement was adopted in 1878, and contemplated the obtaining of a clear channel with a width of 30 feet and a least depth of 18 inches during five months of the year by the removal of rocks, snags, and other obstructions. This river was practically closed before work was commenced, except during rises of considerable height.

The stream was once improved by the State of Virginia by the construction of six locks and dams. The locks were constructed of timber, and, as a matter of course, after a time the charges for repairs rendered necessary by the natural decay of the wood became very great, and a little further along the system was abandoned, and what had formerly constituted a useful improvement now became obstructions. The old locks and dams were carried away in part from time to time by floods, so that when the first report on this river was made by Maj. William E. Merrill, in 1875, most of them had been partially washed away, but the ruins of one still constituted the worst obstruction on the river.

There are two milldams—Pecks, 7 miles below Logan, and Lamberts, 19 miles below Pecks—that still constitute serious obstructions to navigation, and have been reported to the Department as such. The authority for their construction in the first place was based upon a permit from the circuit court, and their continuance has been a nuisance and constant damage to the river interests.

The work in previous years has been to cut passageways through the old dams where required, make channels through the shoals for push boats, and remove such obstructions as rocks, snags, logs, stumps, etc., existing in the channel of the river as would interfere with rafting at ordinary and low rafting stages.

The stream is incapable of permanent improvement, as the obstructions in the channel, such as trees, snags, logs, etc., are liable to re-form. The stream up to Logan, a distance of 81½ miles, has an average fall of about 22 inches to the mile.

No work was done in 1894, owing to the fact that when the appropriation became available the water was so low that the boats for the working party could not get upstream.

On May 1, 1895, a party was sent upstream in push boats, to Logan, to work downstream with the falling water. The work done has been with a view to improving low-water push-boat navigation.

For details, attention is invited to report of Assistant Engineer B. F. Thomas, herewith.

APPROPRIATIONS.

June 18, 1878	$2,000	August 11, 1888	$2,000
March 3, 1879	1,000	September 19, 1890	2,000
June 14, 1880	2,000	July 13, 1892	2,000
March 3, 1881	3,500	August 17, 1894	2,000
August 2, 1882	2,000		
July 5, 1884*	2,000	Total	20,500

Money statement.

July 1, 1894, balance unexpended	$28.28
Amount appropriated by act of August 17, 1894	2,000.00
	2,028.28
June 30, 1895, amount expended during fiscal year	58.47
July 1, 1895, balance unexpended	1,969.81
July 1, 1895, outstanding liabilities	1,108.80
July 1, 1895, balance available	861.01
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,000.00

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1895.*

MAJOR: The report upon the work on Guyandotte River, West Virginia, for the fiscal year is herewith submitted.

No work was done last season on account of the extreme low water at the time money became available.

A party was sent out the 1st of May, and, the water being favorable for moving the boats, they were at once taken to Logan, over 80 miles up the river, where work was commenced, moving downstream.

A good piece of work was done at Long Shoal, and at Wolf Shoal a wall 223 feet long was built on the east side; it is 4 feet wide and 2½ feet high. Another wall 98 feet long, 4½ feet wide, and 2½ feet high was built on the west shore. A chute 81 feet wide was made here, and the push-boat chute was cleaned out nicely. At Hill Shoal, on the east side, walls 125 feet long, and on the west side 500 feet long, were built, and a chute 100 feet wide was cleaned out. At Muskrat Shoal 480 feet of wall was constructed and the chute widened to 100 feet. It was necessary to blast some large rocks at the head of the chute, one of which was 20 feet long, 7 feet wide, and 4½ feet high. An old milldam was also partly taken out at this point. A good wall was built on the east side at Green Shoal. At Hamilton Shoal a good piece of work has just been completed. This is the worst shoal on the river. At the head the channel was on the west side, but crossed over to the east side on its course through the shoal. It has now been straightened and widened, and goes down the west side all the way. This necessitated the blasting of quite a number of large rocks which laid on a bar and which caused the channel to cross over. The wall at this shoal is 1,100 feet long, 6 feet wide, and 3 feet high, and the chute is 120 feet wide. Work has also been done at Mud River, Witcher Turnhole, Big Hart Creek, Toneys farm, John Justices, Pecks Dam, Toneys lower farm, Conleys, Prices Shoal, Dingus Shoal, King Shoal, Rocky Bar, John Conleys, Crawley Shoal, Big Creek Shoal, Toney Shallows, Low Gap Branch, John Lamberts, Sand Creek, Buck Lick, Brumfields Landing, Little Ugly Shoal, and between these points. Work will be continued on down

* Made available by act of August 5, 1886.

the river until funds are exhausted, and it is believed that the navigation will be greatly benefited. The work heretofore done has been a great help to all navigation interests, and steamboats, which were not known up there before, make tolerably long seasons now.

No arrangement has yet been made as to the removal of Pecks Dam and Lamberts Dam. The latter party wants $300 to build a chute through his dam. The recommendation heretofore made as to condemning these dams is renewed, and if they were out of the river it would add greatly to its value for all purposes of navigation.

The timber output has increased greatly since these improvements began, until now a larger amount is run than on any stream of its size in this section. The manner in which this output is cared for at the mouth of the river has been a source of annoyance to steamboat men and other interests, as the owners of a boom for holding the timber allow logs to jam and effectually close the stream to everything but their own property. The interests of other navigation have also increased to such an extent that they can no longer submit to these delays, and while the timber trade is much greater than all other interests combined, and should not be crippled or discouraged, yet it should be cared for like it is in the Big Sandy River, without detriment to other interests. If the owners of the boom can not handle the timber without blockading the river, it should be rafted above, and when rafts are formed into fleets, near the mouth, they should be dropped into the Ohio at once. The manner in which it has been managed the past season is a clear violation of sections 6 and 7 of the river and harbor bill approved September 19, 1890.

The work so far done by the crew is as follows:

Snags removed (25.7 feet long, 5.4 feet girth)	52
Trees removed (67.2 feet long, 6.8 feet girth)	17
Stumps removed	21
Trees topped	131
Solid rock removed, cubic yards	393
Loose rock removed, do	2,670

Appropriations for the maintenance and continuing the improvement should be made as heretofore.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. D. W. LOCKWOOD,
Corps of Engineers.

Commercial statistics for fiscal year ending June 30, 1895, Guyandotte River, West Virginia.

Articles.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cross-ties	.....	12,500	60,000	40,000	25,000
Timber	60,000	90,000	120,940	100,000	210,000
Miscellaneous	1,128	1,300	1,310	1,221	2,400
Total	61,128	103,800	182,250	141,221	247,400

List of boats plying on Guyandotte River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
J. T. Hustler	Side-wheel	75	16	2.2	16.68
Favorite	do	103	14.8	2.5	43.64

G G 13.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County. Its course is a little north of west and it empties into the Ohio at Parkersburg; its total length is about 150 miles.

The Little Kanawha Navigation Company owns and operates four locks and dams on this river, which furnish slack-water navigation from

the Ohio up to a point 2 miles above the village of Burning Springs, where the United States lock is located, but the service of this system is very poor owing to the dilapidated condition of both locks and dams. Breaks and washouts are of frequent occurrence during high water and the interruption to navigation is in consequence expensive and harassing.

The present project for the improvement of this river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam to extend slack-water navigation for a draft of 4 feet a distance of 12 miles above the point reached by the navigation company and the improvement of the natural channel of the upper river by the removal of obstructions, etc., for a distance of 80 miles, the object of the latter being to obtain a channel of a minimum width of 40 feet with a depth of 2 feet for at least four months in each year.

The lock and dam for extending slack-water navigation above the works of the Little Kanawha Navigation Company are completed, the lock having been opened to navigation December 2, 1891. This gives, theoretically, 4-foot navigation to and a little above the mouth of the west fork.

During the extreme low water of the summer the lower miter sill is frequently out of water owing to the leaking of the dams of the Little Kanawha Navigation Company. The dam at Palestine, 9 miles below Burning Springs, is practically bad, so that at times, when water is running over the crest of No. 5, the upper surface of the lower miter sill of the lock will be out of water fully 6 inches.

No work on the general improvement of the river has been done since the completion of the lock in 1891.

APPROPRIATIONS.

August 14, 1876	$7,300	August 5, 1886	$16,875
June 18, 1878	18,000	August 11, 1888	25,000
March 3, 1879	18,000	September 19, 1890	40,000
June 14, 1880	15,000		
March 3, 1881	40,000	Total	211,175
August 2, 1882	31,000		

Money statement.

July 1, 1894, balance unexpended	$24.88
June 30, 1895, amount expended during fiscal year	1.60
July 1, 1895, balance unexpended	23.28
July 1, 1895, outstanding liabilities	13.07
July 1, 1895, balance available	10.21

NOTE.—For commercial statistics and list of boats see report for operating and care, etc., Little Kanawha River, West Virginia.

G G 14.

OPERATING AND KEEPING IN REPAIR THE LOCK ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

This lock, known as No. 5, is located about 42 miles from the mouth of the river and above the four locks and dams owned and operated by the Little Kanawha Navigation Company. It was opened to navi-

gation December 2, 1891, and since that time, with the exception of a few days, has been in condition to be operated continuously.

Owing to the condition of the locks and dams of the Little Kanawha Navigation Company the navigation of the river is intermittent, being interrupted on the one hand by high water, which prevents the locks being used when the depth on the crests of the dams exceeds 5 feet, and on the other hand by low water, i. e., insufficient depth on the lower miter sills, when the loss from leakage through the dams and evaporation exceeds the natural discharge of the stream.

The dams are in no sense tight, and this is illustrated by the fact that at times when the pool above the United States dam has been full the lower miter sill of the lock has been exposed.

During the past year a new timber and concrete floor was put in the lock. The dam was repaired by replacing sheeting that had been torn off by floating timber and drift. The bank about abutment was protected by riprap and the crib above the lock filled with stone.

ALLOTMENTS.

1892	$1,500.00
1893	4,426.65
1894	3,837.97
1895	3,491.03
Total	13,255.65

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Little Kanawha River, West Virginia, improved by lock and dam during the fiscal year ending June 30, 1895.

Month.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1894.				
July	$95.00	$57.15	$16.40	$168.55
August	490.00	2,093.60		2,583.60
September		130.94	53.14	184.08
October	95.00			95.00
November	95.00			95.00
December	95.00			95.00
1895.				
January	95.00	1.20	17.65	113.85
February	95.00			95.00
March	95.00		3.00	98.00
April	95.00		33.30	128.30
May	95.00			95.00
June	95.00		17.75	112.75
Total	1,440.00	2,282.89	141.24	3,864.13

Commercial statistics for fiscal year ending June 30, 1895, Little Kanawha River, West Virginia.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Coal	1,100	10,507	3,100	1,280	644	700
Lumber	8,540	28,677	20,486	18,720	8,552	12,450
Oil	678	1,450	1,738	666	1,230	1,960
Staves	24,500	26,964	10,050	8,470	22,113	23,000
Timber	70,000	59,708	109,337	48,386	47,250	108,000
Ties, railroad	27,650	48,312	92,200	53,500	21,923	16,420
Passengers	1,563	1,500	1,343	1,450	1,200	1,310
Miscellaneous	6,084	13,575	6,000	4,600	3,500	15,400
Total	140,115	190,668	244,254	137,072	106,412	179,260

List of boats plying on Little Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
C. C. Martin*	Stern-wheel	103	18.2	2.9	76.78
Oneida	do	104	19.5	4.2	75.78
W. A. Hilton	do	105	22.5	3.6	67.54
J. King (tow)	do	90	15	3	34.93
D. T. Watson (tow)	do	90	17	2.6	80.45
Mary E. (tow)	do	86	13.6	3.6	19.34
Lulu F. (tow)	do	98.4	15.1	2.6	37.16

* New line.

Report of lockages on Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1895.

[Lock No. 5.]

Days operated	193
Days suspended	172
Going up:	
Steamboats	231
Barges and flats	65
Miscellaneous	46
Going down:	
Steamboats	230
Barges and flats	71
Rafts	1,068
Miscellaneous	61
Total crafts and flats passing	1,772
Total number lockages	1,617

NOTE.—Suspension of navigation on one hundred and twenty-eight days due to lack of water in pools of the Little Kanawha Navigation Company, and on forty-four days on account of ice and high water.

G G 15.

PRELIMINARY EXAMINATION OF THE LOWER PART OF THE LICKING RIVER, KENTUCKY, FOR AN ICE HARBOR, INCLUDING LOCK AND DAM, AT A POINT ABOUT 3 MILES FROM ITS MOUTH.

[Printed in House Ex. Doc. No. 60, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report dated October 10, 1894, by Maj. D. W. Lockwood, Corps of Engineers, of the results of a preliminary examination of the lower part of the Licking River, Kentucky, "for ice harbor, including lock and dam, at a point about 3 miles from mouth of Licking River," made to comply with provisions of the river and harbor act of August 17, 1894.

It is the opinion of Major Lockwood, concurred in by the division engineer, Col. O. M. Poe, Corps of Engineers, and by this office, that the lower Licking River is not worthy of improvement by the General Government for the purposes of an ice harbor.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, October 10, 1894.

GENERAL: In compliance with instructions contained in Department letter of August 20, 1894, I have the honor to submit a report of a preliminary examination of the lower part of the Licking River "for ice harbor, including lock and dam, at a point about 3 miles from mouth of Licking River, Kentucky," called for in river and harbor act of August 17, 1894.

It is assumed that the lock and dam are to be considered primarily in connection with an ice harbor, the object of the dam being to break the ice coming down the Licking.

In 1872 Maj. William E. Merrill made an exhaustive report upon the question of establishing a "harbor of refuge" at the mouth of the Licking. A survey was also made about this time, under his direction, extending up the river about 3 miles, or to a point a little above the location of the lower lock of the old system started by the State of Kentucky about fifty years ago. At the time of the survey the rock bar in the Ohio, at the mouth of the Licking, would not permit the entrance of a boat drawing 1 foot of water at low water. A project for deepening the entrance to give a draft of 4 feet is now being carried out as appropriations are made from year to year, the estimated cost of same being $95,037. When this work shall have been completed there will be 4 feet depth of water in the Licking at low water from its mouth in the Ohio to a point 5,500 feet above, or a little over 1 mile in extent. It would appear from the foregoing that should a lock and dam be built in the lower river the proper location for it would be near the head of the 4-foot stretch, and that the lower miter sill should be 4 feet below low water in the Ohio. If a lock and dam were located about 3 miles from the mouth of the river, with the lower miter sill of the lock 4 feet below low water in the Ohio, then it would be necessary to excavate an entrance about 1¾ miles long to carry 4 feet to it, and a part of this would be through rock. The location of the lower lock, adopted by the State engineers in 1836, can not be taken as a guide at the present time. That lock was at the 3-mile ripple.

In his report, dated September 15, 1836, Mr. Sylvester Welch, chief State engineer of Kentucky, states: "There has been no time during the present season when the river has been down to what is called low water." Still the locations of the locks had been determined on, and detailed estimates submitted of cost, providing for a 6-foot navigation. Mr. Welch, in the report referred to above, states: "The depth of water in all cases is supposed to be 6 feet;" and yet, to obtain that depth from the Ohio to a point 3 miles up the Licking, he estimated the cost at $15,000, while the latest estimate for obtaining a 4-foot channel from the Ohio to a point 5,500 feet up the Licking is, as already stated, $95,037. It seems more than probable that had the survey upon which Mr. Welch based his estimates and made his locations of sites been made at low water in the Ohio the history of the improvement of the Licking River by the State of Kentucky might have been different from what it is. The improvement of the Licking River was stopped in 1842, after an expenditure of $372,520.

The lock which the State started to build at 3-mile ripple was to have a lift of 17.5 feet, and this was to give 6 feet of water to the second

lock, which was located 3 miles above, or 6 miles from the mouth. In his report of 1872 Colonel Merrill stated that the lift for locks on the Licking should be about 10 feet, but if a lift of 15 feet even be taken for the first lock the length of the pool would be less than 3 miles, and as the clause in the river and harbor bill calling for an examination mentions but the one lock and dam, it can readily be seen that the cost per mile of slack water would be excessive if but the one were contemplated. A lock and dam, located as it should be located, about 5,500 feet above the mouth, would seriously interfere with the use of that part of the river below it as an ice harbor, for the reason that, first of all, it would materially diminish the area of readily accessible river, and in the second place, with every small rise in the Licking, the Ohio being at a low stage, the current for some distance below the dam would be too great for mooring boats with safety. It would then materially decrease the value of the area between the dam and the mouth of the river for storing boats out of commission and those loaded with coal for the Cincinnati, Covington, and Newport markets, and these would be the only boats that, under ordinary circumstances, will occupy this stretch of river when the channel through the bar at the mouth is completed.

The pool above the dam would be of little, if any, use as an ice harbor, for the reason that an ice harbor, to be of service, must be readily accessible, and this area could only be reached by the comparatively slow process of locking, and in the meantime the pool would probably be frozen over, there being less current in it than in other parts of the river; in all probability it would be frozen up solidly some time before the Ohio was closed. Again, should the pool be frozen over and a rise come in the Licking, ice, boats, and everything in it might, and probably would, go over the dam and out of the river together. For several months in nearly every year the discharge of the Licking would, at the most, barely keep the pool above the dam full. There would be some leakage through the dam and about the wickets of the lock, and, besides, the surface of the water being much increased by the dam, the loss from evaporation would be great. In consequence the pool would be practically stagnant and at the same time the receptacle of sewage, etc., from the two cities of Covington and Newport within certain limits. The liquid refuse from two large distilleries and that from a large gas works and two abattoirs, which is now discharged into the Licking, would go into the first pool. The effect of all this would be but detrimental to the health of people living near the river.

The Licking is a small river with a steep slope, and the ice that comes out of it is broken up and in comparatively small masses or cakes, so that the dam, with its varying fall, due to more or less backwater from the Ohio, is not a necessity, and ice breakers properly placed could doubtless answer the purpose of breaking the ice better than a dam. As a means of avoiding, or lessening, at least, the danger from run outs, ice, drift, etc., in the Licking, Major Merrill, in his report of March 21, 1872, discussed at length the subject of securing protection for boats, etc., by excavating a harbor in the right bank near the mouth, but did not recommend this plan on account of the great cost of obtaining even a limited protected area and maintaining it afterwards.

In the winter of 1876–77 the Ohio was frozen over, and the damage done to floating craft at Cincinnati when the ice commenced moving was $276,545.

Under date of December 28, 1877, Major Merrill made a report in accordance with a resolution which passed the House of Representatives March 2, 1877, and which read as follows:

"*Resolved*, That the Secretary of War be requested to report to Congress on the best methods, by harbors of refuge or otherwise, of protecting the river commerce at Cincinnati from floes of ice in the Ohio."

The Licking River itself is much used as a harbor of refuge, but it is considered a hazardous one, as this stream is subject to rapid rises that make it unsafe even in summer. In obedience to the act of Congress approved March 3, 1871, I made a survey of the mouth of the Licking as a harbor of refuge, and my report was printed in Ex. Doc. No. 252, House of Representatives, Forty-second Congress, second session. It was also reprinted in the Annual Report of the Chief of Engineers for 1872, pages 420–425, and I would refer to these documents for further information, merely stating that the largest lateral harbor that could well be made near the mouth of the Licking was estimated to give an available area of 9.8 acres, and that its least cost was estimated at $741,000, of which $167,000 was the cost of excavating a channel through the wide rock bar that now obstructs the mouth of this river.

In the report of December 28, 1877, Major Merrill estimates that an area of 65 acres would be required to shelter the winter commerce of Cincinnati.

Under dater of January 4, 1879, a Board of Officers of the Corps of Engineers, convened by Special Orders, No. 82, Headquarters, Corps of Engineers, July 26, 1878, submitted a report to the Chief of Engineers on the subject of protecting the commerce of Cincinnati from floes of ice in the Ohio River. The Licking River does not appear to have been considered.

In my opinion the lower Licking is not worthy of improvement by the General Government for an ice harbor, for the following reasons:

First. The average slope of the river for the first 51 miles is 19 inches per mile, so that run outs from it are dangerous at all times, and especially so when accompanied by ice.

Second. Insufficient area at lower stages, when ice is forming, for mooring boats.

Third. The above objection holds good with the entrance deepened to 4 feet at low water. This entrance, while sufficient for ordinary commercial requirements, would hardly answer in cases where large fleets of boats were to be taken through in a hurry, and under the conditions that exist just preceding the closing of the Ohio by ice.

Fourth. An artificial harbor excavated in the bank would be excessively expensive for the area obtained, would involve an annual expense for maintenance, and, if so located as to be out of the current of the Licking, would freeze over before the Ohio was closed by ice.

Fifth. A lock and dam at a point about 3 miles from the Ohio could only be reached by excavating the lower entrance for a distance of about 1¾ miles, part of this distance through rock. The cost per mile of slack water secured would be excessive, while the advantages gained in a commercial way would be slight. The proper location for commercial purposes would be at a point about 5,500 feet from the Ohio, and this would interfere materially with the use of the river below it for refuge. The breaking up of the ice can be secured by cheaper constructions, such as stone ice breakers or piers.

In conclusion, I would state that some boats are annually laid up in the Licking, but they are taken in at favorable times. Boats in commission will not seek an ice harbor until compelled to, and an ice harbor, to be of any use, must be readily accessible up to the time that the Ohio is closed. I am of the opinion, from the past history of this matter, that the Licking might be difficult to reach at such times.

There is always danger to be apprehended of a run out in the Licking, not only to boats in it, but even to boats in the Ohio.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 16, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

For the reasons assigned herein by Major Lockwood, I concur in his conclusion that the lower Licking is not worthy of improvement by the General Government for the purposes of an ice harbor.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

G G 16.

PRELIMINARY EXAMINATION OF GUYANDOTTE RIVER, WEST VIRGINIA, WITH A VIEW OF IMPROVEMENT BY LOCKS AND DAMS.

[Printed in House Ex. Doc. No. 39, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEES,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report dated November 8, 1894, by Maj. D. W. Lockwood, Corps of Engineers, giving results of preliminary examination of Guyandotte River, West Virginia, "with a view of improvement by locks and dams," as provided for by river and harbor act of August 17, 1894.

Major Lockwood reports that, since 1878, more or less work has been done on the Guyandotte in the way of improving navigation for push boats and running out logs, but that in his opinion the river is not worthy of improvement by the General Government in the manner indicated in the act. Col. O. M. Poe, Corps of Engineer, the division engineer, also reports the Guyandotte River as not worthy of improvement by locks and dams, and this conclusion is concurred in by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER-OFFICE,
Cincinnati, Ohio, November 8, 1894.

GENERAL: In compliance with instructions contained in Department letter of August 20, 1894, I have the honor to submit the following report of a preliminary examination of "Guyandotte River, West Virginia, with a view of improvement by locks and dams."

A preliminary examination of this river, from its mouth to Logan Court House, a distance of 81½ miles, was made under the direction of Maj. William E. Merrill, Corps of Engineers, in compliance with requirements of river and harber act approved June 23, 1874, and the report thereof published in Annual Report of the Chief of Engineers, United States Army, for 1875, commencing on page 747.

This preliminary report was accompanied by maps of the stream, as well as a profile, and contained estimates of cost of carrying slack water to the coal deposits about Logan Court House.

Since 1878 more or less work has been done on the Guyandotte in the way of improving navigation for push boats and running out logs. I understand that but one steamboat has ever made a trip to Logan Court House, and as the construction of the Norfolk and Western Railroad has rendered it easier and more expeditious to deliver freight to points on the river by comparatively short hauls from the railroad than by the old method of push-boating from the Ohio, it would appear that any further improvement of the natural river should be in the timber interests.

Prior to the war a company, acting under a charter from the State of Virginia, constructed six locks and dams in this river, carrying slack water from the Ohio River to above the "Falls" of the Guyandotte, the upper lock being 30 miles from the Ohio. These locks and dams were of timber cribbing, roughly constructed, and the system had hardly been in operation four years when it failed, and the dams then became the worst obstructions to navigation on the river. These old dams, however, had about disappeared when the United States commenced work in 1878, from natural decay of the material of which they were built, floods, and the efforts of people interested in the navigation of the river.

The general features of the stream are as follows: The difference of elevation between low water at its mouth and at Logan Court House, 81½ miles, is 147.76 feet, or an average of nearly 22 inches per mile. For the lower 30 miles, or to the falls, the bottom is sandy, with a very regular slope; but above that point the usual conditions found in streams of steep slope exist, i. e., alternate pools and shoals. Above Logan Court House for a distance of about 25 miles the bed of the stream is widened out in places, and islands interfere with the running of logs, the tendency of the existence of the islands being toward the formation of jams in the chutes, while at certain stages logs pile up on the islands themselves. The upper stretch, covering 13 miles from the forks downstream, is a typical mountain river, with a very steep slope, in some cases this being over 25 feet to the mile, with rock bars and detached bowlders in the bends, making it difficult to run out logs except on tides of 10 feet or over, when large numbers of logs are sure to pile up on the islands below.

The banks in the lower portion of the river are of material easily washed, and as they are cleared of timber, etc., will become more

unstable. The country bordering on the stream is not adapted to agriculture, although it is stated that stock raising may develop into quite an important interest. Commencing at Upper Two Mile, 28 miles from the Ohio, and extending to Logan Court House, there are continuous veins of bituminous coal, but containing shale and partings in many cases, which, as a matter of course, lessen their commercial value. It would seem to me that if these coal veins are as valuable as they are claimed to be, they would have been more fully developed before this. It is also claimed that "nodular, or 'kidney' iron ore is found scattered over all the valley, and occasionally in place." The river runs through a country abounding in valuable timber—this is beyond a question; but the difficulties encountered in rafting or in running loose logs are such that nothing like the full output the region is capable of has ever been reached. The rock bars in the upper part of the river will have to be smoothed off, the large bowlders in the bends blasted down, the various mill and other dams owned by private parties will have to be removed, and some arrangements, like shear booms, put in place at the heads of islands before logs can be run out profitably. The great risk now is the probability of logs being hung up and left out of water during the succeeding summer, and their consequent deterioration in value.

In my opinion the river is not worthy of improvement by the General Government in the manner indicated in the act, i. e., by locks and dams, for the following reasons: (1) The present and prospective demands of the probable commerce of the locality do not, in my opinion, warrant the expenditure of so large a sum as would be required to carry slack water to the vicinity of Logan Court House, a distance of 81½ miles; the difference of level to be overcome in this distance being 147 feet, at least 10, but more probably 12, locks and dams would be required; this would carry slack water well into the coal region. Slack water to Logan Court House would be of no material advantage to the lumber interests, as the great natural obstructions to running rafts of loose logs are above this point—first, among the islands, and then in what may be termed the "rapids," the stretch of 13 miles from the forks down. (2) The stream itself is not well adapted for improvement by locks and dams. In his report to Maj. William E. Merrill, Corps of Engineers, in 1875, Assistant Engineer A. L. Cox states that, in his opinion, the discharge would never fall below 20 cubic feet per second during the low-water season; but as he estimates that the clearing of the timber from the banks and the country about the river would raise the flood line 10 to 15 feet above what it then was, it is more than likely that the low-water discharge would be materially decreased from the same cause.

Taking the low-water discharge at 20 cubic feet per second, it must be borne in mind that the dams would increase by tenfold the area for evaporation, and this increased loss from this source, together with the leakage through the dams and wickets, would give a considerable period during each year when the system would fail from lack of water. Mr. Cox recommended, in order to obtain sufficient spill for the dams, that locks be set into the banks; this would make awkward approaches, and necessitate the dredging of the lower entrances after each high water, thus adding to cost of maintenance. Mr. Cox, in his report, also states: "The first lock will, as seen upon map and profile, stand upon the bank of the Ohio River." The reason for this is manifest—there is no navigable water in the Guyandotte near its mouth at low water, and,

on the other hand, it is some distance to navigable water in the Ohio at such times.

Very respectfully, your obedient servant.

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 12, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

I concur with Maj. D. W. Lockwood, Corps of Engineers, that Guyandotte River, West Virginia, is not worthy of improvement by locks and dams.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

G G 17.

PRELIMINARY EXAMINATION OF LITTLE KANAWHA RIVER, WEST VIRGINIA, WITH A VIEW OF IMPROVEMENT BY LOCKS AND DAMS.

[Printed in House Ex. Doc. No. 98, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 8, 1894.

SIR: The river and harbor act of August 17, 1894, provides, in section 10, for a preliminary examination of Little Kanawha River, West Virginia, "with a view of improvement by locks and dams, including an estimate of the probable cost to the Government of each lock and dam now in existence on said river and not owned by the Government."

The duty of making this examination was assigned to Maj. D. W. Lockwood, Corps of Engineers, and I have now the honor to submit the accompanying copy of his report of December 1, 1894, on the subject.

It is his opinion, concurred in by the division engineer, Col. O. M. Poe, Corps of Engineers, and by this office, that the river is not worthy of improvement by the General Government in the manner indicated in the act.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, December 1, 1894.

GENERAL: In compliance with Department letter of August 20, 1894, I have the honor to submit the following report of a preliminary examination called for in river and harbor act of August 17, 1894, of "Little

Kanawha River, West Virginia, with a view of improvement by locks and dams, including an estimate of the probable cost to the Government of each lock and dam now in existence on said river and not owned by the Government."

This river was originally surveyed in 1838 under the direction of Mr. M. Crozet, principal engineer of the Board of Public Works, State of Virginia. Its headwaters are very near those of the Buckhannon River, a branch of the Tygarts Valley River, which is itself a branch of the Monongahela, and also near those of Elk River, a branch of the Great Kanawha. Its general course is northwest, through Braxton, Gilmer, Calhoun, Wirt, and Wood counties to the Ohio River at Parkersburg; it is very crooked and abounding in sharp turns, especially in Calhoun and Wirt counties, where, in a direct distance of 24 miles, it is 53 by the river.

The country through which the river runs is extremely rough, with hills throughout its entire length. Above Burning Springs the river bottoms are seldom more than a few hundred feet wide, and the country is thinly settled. About 1867 the Little Kanawha Navigation Company, under authority granted by certain acts of the legislature of the State of West Virginia, the first of which was passed February 4, 1863, commenced the improvement of the lower part of the Little Kanawha by locks and dams. This improvement, after many delays, was ultimately completed to carry slack water to a point about 40 miles above Parkersburg. In 1874 a survey of the river was made under the direction of Maj. William E. Merrill, Corps of Engineers, by Mr. E. J. Carpenter, assistant engineer, the report of which was printed in the report of the Chief of Engineers, United States Army, for 1875, commencing on page 740. Mr. Carpenter gives the dimensions of the locks built by the navigation company as follows: Length, 143 feet; width, 23 feet. At present these locks are being operated by the navigation company when the stage of water will permit.

The river and harbor act of June 14, 1880, specifically provided for an additional lock and dam, to be built by the United States near the head of slack water of the navigation company's system, but owing to the small appropriations made by Congress the lock was not opened for navigation until December 2, 1891. The present head of slack water is near the mouth of the West Fork. At various times since and including 1877 work has been done in this river with a view to improving rafting facilities and push-boat navigation, such as the removal of large rocks in bends and on shoals, the construction of brush and stone dams to close chutes, and the putting in of inclines at the milldams where formerly a rise of 8 feet was necessary to get boats and rafts over. The principal output of the region through which the Little Kanawha runs that can be brought out by the river at present is timber, and large quantities of this, in the shape of logs, railroad ties, and staves, are brought out each year when there are suitable tides. Rafting is difficult on account of the river being narrow and crooked, with sharp bends; but for all that, with the booms in the pool above the United States lock, the loss is not serious. At Burning Springs a 20-inch vein of coal is found, and this has been worked to some extent. Three miles above Glenville (and 106 miles above Parkersburg) a vein of coal from 5 to 7 feet thick is found, located some distance above the river bed.

There seems to be but little doubt that there are valuable deposits of coal on the upper river, but it is questionable whether a route to market, via the Little Kanawha, at all commensurate with the great cost

of such a route, can be established. The distance from the West Fork, the present head of navigation, to Glenville is 55 miles, while the difference of level is 80 feet, and as the average lift per lock would be about 12 feet, it would require seven additional locks to carry slack water to that point and give 4 feet depth. The carrying of slack water above that point need not be considered, in my opinion. The only reason for extending slack water above the West Fork is to provide a means for marketing, by water, the coal found at and above Glenville, and even if additional locks and dams were constructed above the present United States lock the old locks and dams now owned and operated by the navigation company would reduce the efficiency of the entire system to such an extent that only a limited navigation would result. The United States lock was built to accommodate a coal boat of standard size, so far as length and width are concerned, while the depth on the lower miter sill is 4 feet; the navigation company's locks are 23 feet wide, so that a special-sized coal boat only can pass them.

The condition of the slack-water system on this river at present is as follows: The navigation company's four locks and dams carry slack water up the river about 40 miles; then the United States lock and dam extend the system a short distance above the mouth of the West Fork, which is 48 miles from the Ohio. The navigation company's locks and dams are in bad shape, more especially the former, as the dams are capable of being repaired and made tight. The locks, however, from the manner in which they were originally constructed, are constantly deteriorating, and it will not be many years before they will become absolutely useless as locks.

Lock No. 1, 3½ miles from the Ohio, is in particularly bad shape; at one time a part of the river wall went out, and the break was repaired with timber cribbing filled with stone.

In some of the locks the masonry is coursed wholly or in part, but in most cases the joints are irregular, the stone roughly cut, and the mortar of an inferior quality. In my opinion the cost of thoroughly repairing these locks would be so great that sound economy would indicate, preferably, a complete rebuilding, particularly when the fact of their being so narrow is taken into account.

These locks are impassable when there is about 5 feet of water on the dams, the walls of the chambers being only about that much higher than their crests, and, in my opinion, it would not be safe to raise the walls much higher than they now are. The dams leak badly, and when the discharge of the river gets small the system becomes inoperative from insufficient depth on the lower miter sills. It will thus be seen that during rises navigation fails before the dams are drowned out (except from backwater), and at low water the leaky dams permit the escape of water to such an extent as to interfere with navigation. The failure of navigation during low stages is not entirely due to faulty construction of the old locks and dams; there are times when the supply of water is not sufficient to keep the pools full, even if the dams were all tight. In 1892 there were twenty days when the depth of water on the lower miter sill of the Government lock was less than 2 feet, thirty-seven days when it was less than 3 feet, and ninety days when it was less than 4 feet (this does not include the month of October, usually a low-water month, the records for this month being missing). In 1893 there were seventeen days when the lower miter sill was exposed, forty-seven days when the depth of water on it was 2 feet or less, fifty-four days when it was 3 feet or less, and one hundred and eleven days when it was less than 4 feet. In 1893 there were fifty-four

days when the water in the pool above the Government dam was below the level of the comb stick.

The season of 1894 has been an unusually dry one, and navigation has been suspended since about the middle of July. On the 19th of that month the depth of water on the lower miter sill of the Government lock was 2 feet, and the records show that from about August 1 to November 1 the miter sill has been exposed; the record for November will show the same, or about the same, condition of affairs. Since the latter part of August the water above the Government lock has been below the level of the comb stick of the dam, and on October 31 it was 4 feet below; in other words, the water supply since August 26 has not been sufficient to supply the evaporation and leakage in one pool. This morning's River News states, under date of November 30, that "the pools are filling up," and that "the *Lulu F.* will resume her trips." This boat draws less than 2 feet; the regular boats do not run on less than 2 feet 8 inches; navigation has failed this season, therefore, for four and one-half months.

As stated already, this has been an unusually dry season, and this condition of affairs might not obtain again in many years.

With regard to the probable cost to the Government of each lock and dam now in existence on said river and not owned by the Government, I have the honor to invite attention to a letter from L. B. Dellicker, secretary, Little Kanawha Navigation Company, appended to this report, giving the cost of each of the four locks and dams owned by that company, and the amount ($250,000) for which the board of directors of the company would recommend to its stockholders to sell the property to the United States. This amount probably includes not only the original cost, but also the cost of keeping in repair since construction. The divided jurisdiction or control of improvements on this river has not been of advantage to the general interests of the locality. While the Government has aimed to keep its lock available for use at all times, having no regard to the question of revenue, the locks and dams below it, operated in the interest of stockholders, who naturally expect a return for the amounts they have invested, have not been kept in such a state of repair as to insure to the locality affected all the benefits possible from such a system of navigation.

In my opinion it will not be many years before the annual cost of necessary repairs will exceed the revenue derived from tolls, and the condition of affairs will then be worse than now.

In conclusion, I would state that I do not consider this river worthy of improvement by the General Government in the manner indicated in the act of Congress calling for the examination, for the following reasons: (1) Any extension of the system, without the United States having full control of the river, would result only in a partial benefit, and $250,000 is a large sum to pay for the old locks, which should be rebuilt if it is expected to bring out coal, as otherwise, with the small boats that would have to be used, the cost of transportation would be too great; the old locks will not last much longer, anyway. (2) The water supply during the summer months is insufficient as the system now is to keep the pools full, and, with additional locks and dams, the area of the water surface would be much increased, and loss from evaporation consequently greater than at present; the result would be that the system would become inoperative earlier in the summer than now. If the old dams were made as tight as the present Government dam, navigation would last some longer than it does now, but with the system extended and all the dams tight there would be a long time each

year when none but the lightest-draft boats could run, and times when even such navigation would fail. (3) In the three years since the United States lock has been in operation there have been two hundred and twenty-two days when the depth of water on its lower miter sill was 6 feet or over, an average of seventy-four days each year, and during some of this time the water was too high for locking. It will thus be seen that only light-draft barges or flats could be used in bringing out coal, and in my opinion coal could be delivered at Parkersburg via the Ohio at a cheaper rate than via the Little Kanawha, with tolls abolished and the system completed from Glenville to Parkersburg, because in the narrow, crooked river a towboat can handle but a few pieces, and but one piece at a time can pass the locks. This condition of affairs, in connection with the comparatively small quantity each barge or flat can carry, will materially increase the cost of transportation.

Nine photographs,* giving views of the four locks belonging to the navigation company and the United States lock, are forwarded in a separate package.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., December 5, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the views and conclusions of the district engineer as herein expressed.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

LETTER FROM MR. L. B. DELLICKER, SECRETARY LITTLE KANAWHA NAVIGATION COMPANY.

OFFICE OF LITTLE KANAWHA NAVIGATION COMPANY,
Parkersburg, W. Va., October 27, 1894.

At a meeting of the board of directors of the Little Kanawha Navigation Company held at its office in the city of Parkersburg, W. Va., on the 27th day of October, 1894, the board directed its secretary to return the following answer to the communication of Maj. D. W. Lockwood, United States Engineers, under date of August 23, 1894:

The board of directors of the Little Kanawha Navigation Company say that the cost of all four of the locks and dams owned by said company is $250,365.78, which is distributed as follows:

Cost of—	
Lock No. 1	$70,314.86
Lock No. 2	60,623.00
Lock No. 3	60,747.76
Lock No. 4	58,680.16
Aggregating	250,365.78

* Omitted. Printed in House Ex. Doc. No. 98, Fifty-third Congress, third session.

The board of directors of this company will recommend to its stockholders to sell this property to the United States for $250,000. This recommendation does not embrace any estimated value of the franchise under which this company is operating, but the board of directors state that these works are now paying a dividend of 6 per cent per annum on its capital stock, after keeping the works in repair, payment of fixed charges, and setting aside a considerable sum annually for contingent fund. As to purchase of one lock and dam, the directors are not willing to recommend any sale of single lock and dam, unless the purchase be made at the upper end, or No. 4 first, and then down the river in regular order, this being, in their opinion, the most advantageous to the United States, as it already owns a lock and dam next above No. 4 of this company, which has cost the Government a large sum of money.

Respectfully, yours,

L. B. DELLICKER,
Secretary Little Kanawha Navigation Company.

Maj. D. W. LOCKWOOD,
United States Engineers.

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